EIGHTH ANNUAL REPORT
OF THE
METROPOLITAN SEWERAGE COMMISSION

1897

DEER ISLAND PUMPING STATION. DWELLING HOUSE FOR EMPLOYEES.

. . . COMPLIMENTS OF . . .

Metropolitan Sewerage Commissioners

OF MASSACHUSETTS.

HOSEA KINGMAN,
TILLY HAYNES,
GEORGE A. KIMBALL,
Commissioners.

EDWARD P. FISK, Clerk.

WILLIAM M. BROWN, Jr.,
Chief Engineer and Superintendent.

1 MT. VERNON STREET,

BOSTON.

PUBLIC DOCUMENT . . . . . No. 45.

EIGHTH ANNUAL REPORT

OF THE

BOARD

OF

METROPOLITAN SEWERAGE COMMISSIONERS,

FOR THE

YEAR ENDING SEPTEMBER 30, 1896.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1897.

Commonwealth of Massachusetts.

To the Honorable the Senate and the House of Representatives.

The Board of Metropolitan Sewerage Commissioners, created by chapter 439, Acts of 1889, presents its annual report, which is the eighth since its organization, and covers the year ending Sept. 30, 1896.

In our report for 1895 (Public Document No. 45, 1896), the practical completion and opening of the north metropolitan line to the towns and cities thereon, with the exception of about five hundred feet of Section 35 in the city of Somerville, was reported. The latter section was so far completed that on Dec. 28, 1895, notice was sent to the proper authorities of the cities of Medford and Somerville that on and after Jan. 5, 1896, the said section would be in operation, and connections could be permitted therewith upon application to this Board. This and the Charles River system have been continually in operation during the year.

The work of construction has progressed steadily upon the Neponset valley system since the Board voted at its meeting of June 5, 1895, to enter upon the construction thereof as authorized by chapter 406, Acts of 1895. Your attention is respectfully invited to the report of our chief engineer, and the tables following in connection with this report, for fuller details.

NORTH METROPOLITAN SYSTEM.

In our last report, speaking of this system, after stating that about five hundred feet of Section 35 in Somerville remained to be constructed, we say: —

> When this is completed the total length of sewer upon this system will be about forty-one miles, varying in size from a brick sewer nine feet in diameter at Deer Island, Winthrop and East Boston, to a vitrified pipe sewer twelve, fifteen or eighteen inches in diameter at the opposite termini. This, with the eight and one-quarter miles in the Charles River valley, makes about fifty miles of metropolitan sewers constructed and in operation at this date.

The following settlements for land taken upon this system have been made during the year: —

On Oct. 5, 1895, Wm. B. Rice, by his attorney, A. D. McLellan, made a settlement with the Commonwealth for land in Winthrop, included within the taking of May 7, 1890, recorded in Suffolk Registry of Deeds, book 1934, page 487; and on the 31st of the same month the Boston Ice Company released to the Commonwealth "rights, privileges and easements" in land in Winchester and Woburn, included within the taking made by this Board dated June 2, 1894, and recorded in Middlesex South District Registry, book 2282, page 388. The deed of the ice company is recorded in the aforesaid registry, book 2415, page 329.

On Nov. 14, 1895, settlement was had with Gilbert Lincoln, owner of an estate in Canal Street, West Medford, including a claim for damages to a well on said premises as well as for damage to said Canal Street, a private way included within the taking made by this Board Dec. 23, 1891, and recorded with Middlesex South District Registry, book 2089, page 361. By deed dated Jan. 21, 1896, recorded Middlesex South District Registry, book 2437, page 570, Right Rev. John J. Williams, Archbishop of Boston, quitclaims to the Commonwealth "rights, privileges and easements" in land in Medford belonging to him and used for St. Joseph's Church, included within the taking made by this Board Nov. 25, 1891, and recorded in Middlesex South District Registry, book 2083, page 368.

A deed from Nancy White and others, recorded in Middlesex South District Registry, book 2437, page 569, and dated Nov. 25, 1895, releases the Commonwealth, its officers, agents and servants, from all suits, claims and demands for damages and costs to lands in Woburn, included within a taking made by this Board April 15, 1893, recorded in Middlesex South District Registry, book 2186, page 585; and a deed dated Jan. 10, 1896, from John J. McCormack and others (recorded in Middlesex South District Registry, book 2437, page 571), conveys to the Commonwealth "rights, privileges and easements" in certain lands in Somerville, included within the taking dated May 20, 1893, recorded in Middlesex South District Registry, book 2197, page 139; also a certain parcel of land in fee, with all the rights, privileges and appurtenances thereto belonging, in said Somerville, included within the taking by this Board dated April 27, 1895, and recorded in Middlesex South District Registry, book 2361, page 45.

Philip J. Blank of Winchester, by deed dated March 10, 1896, recorded in Middlesex South District Registry, book 2457, page 566, quit-claims to the Commonwealth "rights, privileges and easements" in two parcels of land in said Winchester, included within a taking made by this Board June 2, 1894, recorded in Middlesex South District Registry, book 2282, page 388.

The President and Fellows of Harvard College, by deed dated April 28, 1896, recorded in Middlesex South District Registry, book 2511, page 330, released to the Commonwealth "rights, privileges and easements" in land in Cambridge, included within the taking made by this Board July 19, 1893, and recorded in Middlesex South District Registry, book 2210, page 481; and similar rights in land lying in the same neighborhood and taken at the same time, belonging to John Holmes and others, have been released by deed dated May 15, 1896, recorded in Middlesex South District Registry, book 2511, page 329.

Damages sustained by sundry persons in their real estate included within takings made at various times by this Board were paid by the Commonwealth upon executions issued from the superior court, as follows: October, 1895, David

Fisher, Woburn, included within the taking made April 15, 1893, and recorded in Middlesex South District Registry, book 2186, page 585; November, 1895, Orray A. Taft, Winthrop, partly in fee, by taking dated April 13, 1890, and recorded in Suffolk Registry, book 1932, page 583, and also by taking dated May 7, 1890, recorded in Suffolk Registry, book 1934, page 487; January, 1896, Martha McLean, Cambridge, included within a taking made July 19, 1893, and recorded in Middlesex South District Registry, book 2210, page 481; January, 1896, H. C. Greene, Everett, by taking dated Oct. 28, 1891, and recorded in Middlesex South District Registry, book 2076, page 262; January, 1896, Frederick M. Burrows, Somerville, included within a taking made May 20, 1895, and recorded in Middlesex South District Registry, book 2197, page 139; January, 1896, Peter C. Brooks, Medford, included within a taking made Dec. 23, 1891, recorded in Middlesex South District Registry, book 2089, page 361, and also by taking dated Jan. 2, 1892, and recorded in Middlesex South District Registry, book 2090, page 291; January, 1896, heirs of Gorham Brooks (Shepard Brooks), Medford and Winchester, included within a taking made July 14, 1893, and recorded in Middlesex South District Registry, book 2210, page 162; April, 1896, Mary Call, Woburn, by taking made April 15, 1893, and recorded in Middlesex South District Registry, book 2186, page 585; April, 1896, Mary Penney, Cambridge, by taking made Jan. 7, 1893, and recorded in Middlesex South District Registry, book 2169, page 457. The settlement with Mary Penney includes land taken from Fred. H. Rindge at the same time, damage to which was assigned to her by the said Rindge.

Land Takings.

No new takings have been made during the year. The additional takings at the East Boston and Charlestown pumping stations, reported in the last annual report (Public Document No. 45, 1896, pages 11 to 13 inclusive) as licensed by the Board of Harbor and Land Commissioners, were submitted to the Honorable Secretary of War, Washington, D. C., for approval early in October, 1895, and replies were received as follows: —

War Department, Washington, D. C., Oct. 19, 1895.

Sir: — Replying to your application of 4th instant, inclosed please find for retention an instrument for granting permission to the Board of Metropolitan Sewerage Commissioners of Massachusetts to extend the structures at Charlestown pumping station, in Mystic River, at Charlestown, Mass.

Very respectfully,

(Signed) Daniel S. Lamont,
Secretary of War.

Hosea Kingman, Esq.,
Chairman Metropolitan Sewerage Commissioners,
110 Boylston Street, Boston, Mass.

With the foregoing communication was inclosed the following instrument attached to the plan sent to the War Department: —

Whereas, By section 3 of an act of Congress, approved July 13, 1892, entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors and for other purposes," it is provided that, without the permission of the Secretary of War, it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty, or structure of any kind outside established harbor lines, or where no harbor lines are or may be established, in any port, roadstead, haven, harbor, navigable river or other waters of the United States, in such manner as shall obstruct or impair navigation, commerce or anchorage of said waters;

And whereas, The Board of Metropolitan Sewerage Commissioners of Massachusetts has applied to the Secretary of War for permission to extend the structures at Charlestown pumping station in the Mystic River at Charlestown, Mass., as shown on the attached drawing;

Now, therefore, This is to certify that the Secretary of War hereby gives permission to the said Board of Metropolitan Sewerage Commissioners to extend the structures at Charlestown pumping station in Mystic River at Charlestown, Mass., as shown on said drawing, upon the following condition: —

That the work herein permitted to be done shall be subject to the supervision and approval of the engineer officer of the United States Army in charge of the locality.

Witness my hand this eighteenth day of October, 1895.

(Signed) Daniel S. Lamont,
[seal] *Secretary of War.*

War Department, Washington, D. C., Oct. 19, 1895.

Sir: — Replying to your application of 4th instant, inclosed please find for retention an instrument granting permission to the Board of Metropolitan Sewerage Commissioners of Massachusetts to extend the structures at East Boston pumping station in Chelsea Creek, Mass.

Very respectfully,

(Signed) Daniel S. Lamont,
Secretary of War.

Hosea Kingman, Esq.,
Chairman Metropolitan Sewerage Commissioners,
110 Boylston Street, Boston, Mass.

With the foregoing communication was inclosed the following instrument attached to the plan sent to the War Department: —

Whereas, By section 3 of an act of Congress, approved July 13, 1892, entitled "An act making appropriations for the construction, repair and preservation of certain public works on rivers and harbors and for other purposes," it is provided that, without the permission of the Secretary of War, it shall not be lawful to build any wharf, pier, dolphin, boom, dam, weir, breakwater, bulkhead, jetty or structure of any kind outside established harbor lines, or where no harbor lines are or may be established, in any port, roadstead, haven, harbor, navigable river or other waters of the United States, in such manner as shall obstruct or impair navigation, commerce or anchorage of said waters;

And whereas, The Board of Metropolitan Sewerage Commissioners of Massachusetts has applied to the Secretary of War for permission to extend the structures at East Boston pumping station in Chelsea Creek, Mass., as shown on the attached drawing;

Now, therefore, This is to certify that the Secretary of War hereby gives permission to the Board of Metropolitan Sewerage Commissioners to extend the structures at East Boston pumping station in Chelsea Creek, Mass., as shown on said drawing, upon the following condition: —

That the work herein permitted to be done shall be subject to the supervision and approval of the engineer officer of the United States Army in charge of the locality.

Witness my hand this eighteenth day of October, 1895.

(Signed) Daniel S. Lamont,
[seal] *Secretary of War.*

The above communications from the War Department at Washington, D. C., licenses the structures petitioned for, and all such structures within tide-water are now fully completed.

Contracts.

The contracts on this system have been but few during the past year, and relate to the completion of the pumping stations at Deer Island, Charlestown and Alewife Brook. On Oct. 4, 1895, the following bids were received for marble flooring at the pumping station at Charlestown : —

Philip H. Butler & Co., Boston, ...	$780 00
Bowker, Torrey & Co., Boston, ...	859 00
Chas. E. Hall & Co., Boston, ...	928 00

No action was taken on these bids, the engineer being directed to obtain bids for granolithic flooring at this station and also at the station at Alewife Brook.

At the succeeding meeting of the Board the engineer submitted the following communication : —

Aberthaw Construction Company,
31 State Street, Boston, Oct. 10, 1895.

Wm. M. Brown, Jr., *Superintendent Metropolitan Sewerage Commissioners, Boston.*

Dear Sir : — We will furnish all materials, labor, etc., and construct a three-inch granolithic pavement, first quality, for fourteen cents per square foot, at the Charlestown and Alewife Brook pumping stations. Germania cement used throughout, and all done in a strictly first-class manner, four-foot square blocks, blue top, smooth finish. Water to be furnished us. Hoping to receive your order, we beg to remain,

Yours very truly,
Aberthaw Construction Company.
T.

The Board thereupon voted to reject all bids received Oct. 4, 1895, for floor at the Charlestown station and to accept the bid of the aforesaid company for granolithic flooring at the Charlestown and Alewife Brook stations. These floors have since been constructed by said company, at a cost of $254.66 for the Charlestown pumping station and $104.64 for the Alewife Brook station.

On Oct. 19, 1895, the engineer was directed to obtain proposals for curbing at Deer Island and bids for interior finish at the Charlestown pumping station, and submit the same to the Board later; and on Oct. 26, 1895, the following bids were submitted for the interior finish at Charlestown: —

Mack & Moore, Boston, Mass.,	$2,250 00
Wm. Richmond & Co., Boston, Mass.,	1,909 00
John S. Jacobs & Son, Boston, Mass.,	1,975 00
Hersee Bros., Roslindale, Mass.,	5,800 00
Wm. H. Keyes & Co., Boston, Mass.,	1,848 00

The Board then voted to accept the bid of Wm. H. Keyes & Co. for the interior finish at the Charlestown pumping station. At the same meeting the engineer also submitted two bids for curbing, rough and cut stone, for use at Deer Island, — one from Walter S. Lyons, Boston, and the other from S. & R. J. Lombard, Boston; and the Board directed him to accept the bid of the latter, amounting to about $630.

Bids have been received for supplying the various pumping stations on this line with coal, particulars of which are given in Table A of the Appendix. The cost of said coal is charged to and appears in the table of expenses for operating and maintaining this system.

The cases mentioned in our last annual report as pending between contractors upon the work and the Commonwealth, for breach of their contract, have been settled during the year as follows: that of the Commonwealth *v.* McGovern & Kitch, contractors for the construction of Section 27 (Cambridge), was settled, after a trial in the Superior Court of the Commonwealth, by a payment of $6,458.53 to the Commonwealth, which has been placed in the hands of the Treasurer, and under the provisions of chapter 192, Acts of 1891, will be applied to the payment of interest upon the loan authorized by chapter 439, Acts of 1889.

The claim of Trumbull & Ryan, contractors for the construction of Section 7, Belle Isle Inlet, was settled by the Commonwealth's payment to the said contractors on July 1, 1896, of $5,000, the said contractors giving the Commonwealth a release, as follows: —

We, Charles A. Trumbull of Lawrence, Mass., and William H. Ryan of East Boston, Mass., in consideration of five thousand dollars to us paid by the Commonwealth of Massachusetts, by order of the Metropolitan Sewerage Commissioners, do hereby acknowledge that we have received full payment and satisfaction of all claims against said Commonwealth, its officers, agents and servants, for work done or materials furnished for section seven of the north metropolitan system, or on account of any contracts relating thereto, or any action of said Board thereunder; and we do hereby release and discharge the said Commonwealth, its officers, agents and servants, from all claims and demands relating to or growing out of such contracts, and especially all claims by reason of the action of said commissioners in terminating the contract entered into with them for the construction of said section.

Witness our hands and seals this first day of July, eighteen hundred and ninety-six.

(Signed) Charles A. Trumbull. [L. S.]
(Signed) William H. Ryan. [L. S.]

Witness: Edw. P. Fisk, to both.

The last case mentioned in our former report, that of the Metropolitan Construction Company, contractors for construction of Section 39, was settled amicably out of court, after various suits and counter-suits had been entered, the Commonwealth paying the said company about fifty per cent. ($3,500) of the amount withheld from their reserve.

Claims of Contractors.

Late in December, 1895, Jones & Meehan, contractors for construction of Section 44 (Winchester), submitted a bill for extras on said section, asking an early consideration thereof, and a hearing was appointed upon said claim and a claim previously filed for extras on Section 30 (Cambridge). This hearing was held Feb. 29, 1896, and afterwards the Board

Voted, To adhere to its vote passed April 7, 1894, awarding said contractors five hundred dollars ($500) in full settlement for all claims upon this section (Section 30).

The Board also

Voted, To allow said contractors one hundred sixty-two and fifty one-hundredths dollars ($162.50) in settlement for all claims upon Section 44, the same to be paid upon their giving the Commonwealth a release satisfactory to the attorney of the Board.

The contractors were duly notified of these votes, but have not as yet (October 1) accepted the award offered them.

Mystic Valley Sewer.

In our last annual report, after speaking of meeting the Sewer Board of Woburn on July 18, 1895, we say (page 26): —

On the same evening the keys of the purifying works in Winchester were delivered to a representative of this Board, and the works there located were closed and abandoned, the sewage formerly treated there being allowed to flow directly into the metropolitan sewer.

The effect of this change is treated more fully by the engineer in his report, to which your attention is respectfully called.

The city of Boston had conveyed with these works to the Commonwealth about five and one-half acres of land, for which this Board immediately began to receive applications for purchase. As the land in question had been taken or purchased by the city of Boston from the Boston & Lowell Railroad Corporation, which is now leased by and forms a part of the Boston & Maine system, this Board considered it advisable to offer said land to the Boston & Maine Railroad, which was done by the following letter: —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, Oct. 21, 1895.

To the President of the Boston & Maine Railroad, Boston, Mass.

Dear Sir: — This Board has offered for sale a tract of land in Winchester, embraced within a taking made July 14, 1893, and recorded in Middlesex South District Registry, book 2210, page

161. As they have had inquiries for it I have been directed to communicate with your corporation, to ascertain if you desire to purchase the same. The land in question embraces the site of the purifying works formerly operated by the city of Boston in connection with the Mystic valley sewer. An early reply would receive the attention of the Board if received in season to submit at the meeting on Saturday next.

For the Board,

Truly yours,

(Signed) EDWARD P. FISK,
Clerk.

After considerable correspondence between this Board and President Tuttle, the following letter was received: —

BOSTON & MAINE RAILROAD, PRESIDENT'S OFFICE,
BOSTON, Dec. 19, 1895.

Mr. EDWARD P. FISK,
Clerk Metropolitan Sewerage Commissioners,
110 Boylston Street, Boston, Mass.

DEAR SIR: — I am authorized to purchase the land at Winchester, about which we have been in correspondence, and to which you last referred in your letter to me of the 9th inst., containing about five and one-half acres, and to pay you therefor $5,500.

Kindly advise me if this offer is accepted, and I will arrange to have our Mr. Sigourney Butler call upon you in regard to drawing the deeds and making payment.

Yours truly,

(Signed) LUCIUS TUTTLE,
President.

To this the Board replied as follows: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, Dec. 21, 1895.

LUCIUS TUTTLE, Esq., *President Boston & Maine Railroad, Boston, Mass.*

DEAR SIR: — Your proposition for the purchase of the land in Winchester, contained in your letter of the 19th inst., was considered by the Board at its meeting to-day, and was accepted, provided that the State shall reserve the barn, and all machinery now on the premises, and that the railroad shall convey to the Commonwealth a right of way over the existing roadway from Bacon

Street up to the sewer location for the purpose of maintaining the sewer, as will be more fully stated by our attorney, Mr. William D. Turner, who will confer with your Mr. Butler in regard to the conveyance.

For the Board,

Very truly yours,

(Signed) EDWARD P. FISK,
Clerk.

The matter was then referred to Mr. Wm. D. Turner, the attorney of the Board, who, after consultation with Mr. Butler and this Board, presented to said Board, at its meeting on Feb. 15, 1896, a deed of even date, conveying to the Boston & Maine Railroad Company the land in question in Winchester, and the Board

Voted, To execute deed of this date, conveying to the Boston & Maine Railroad Company land in Winchester, shown on a plan of even date, entitled "Metropolitan Sewerage Commissioners," plan of land in Winchester, signed by William M. Brown, Jr., superintendent, and that the same be delivered on payment of consideration named in said deed.

The deed was executed by the full Board and acknowledged before the clerk as justice of the peace.

This conveyance was made under the provisions of chapter 251, Acts of 1892, and reserves to the Commonwealth certain machinery and a barn on the land, together with the right to "operate and maintain" the sewer in said land. The deed was delivered and the money, paid to our attorney March 16, 1896, was by him deposited with the Treasurer and Receiver-General of the Commonwealth, who, under the provisions of the aforesaid act, places it to the credit of the metropolitan sewerage loan fund.

The Board has disposed of one other piece of real estate during the past year. The house and lot, No. 63 Pearl Street, Chelsea, was purchased of Frederick Haslam, who conveyed it to the Commonwealth, by warranty deed dated April 28, 1892, for the purpose of constructing a portion of the sewer in that section by tunnelling. On Sept. 5, 1896, T. H. Buck, of T. H. Buck & Co., Chelsea, owners

of adjoining property in that neighborhood, agreed with this Board regarding the purchase of said estate, subject to the rights of the Commonwealth, to operate and maintain the sewer therein, and deposited with this Board a check for $500, payable to the order of the Treasurer of the Commonwealth, agreeing to pay the balance ($1,500) within one year. An agreement to this effect has been duly executed.

At the meeting of the Board on Nov. 2, 1895, the engineer submitted plan and papers from the town of Stoneham, in relation to a local system for said town, in connection with the metropolitan system, and they were referred to him for investigation; and at the subsequent meeting (November 9), he reporting favorably on said plans, the Board approved the same, leaving the matter of detail of connection with the metropolitan sewer to be approved when submitted. One connection for said town was approved by this Board at its meeting on June 6, 1896, which has not been made.

Extension of the North Metropolitan System to Wakefield.

At its meeting on Dec. 7, 1895, a communication from a committee of the town of Wakefield, asking for information regarding sewerage for the villages of Greenwood and Boyntonville in said town, was received and replied to; and on Dec. 14, 1895, the committee, with Louis E. Hawes, the engineer, waited upon the Board, asking that the Board would draft an act providing for the connection of said villages with the north metropolitan system. They were advised to prepare an act according to their ideas and submit the same to the Board for criticism.

The Board at its meeting on Feb. 15, 1896, received from the said committee a communication embodying the provisions contained in the first three sections of the bill presented in House Document No. 798 (1896), entitled "An act relating to sewerage and sewage disposal for the town of Wakefield."

[House No. 798.]

AN ACT RELATING TO SEWERAGE AND SEWAGE DISPOSAL FOR THE TOWN OF WAKEFIELD.

SECTION 1. The territory comprising the villages of Greenwood and Boyntonville in the town of Wakefield is hereby added to the north metropolitan sewerage district, created by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine, entitled "An act to provide for the building, maintenance and operation of a system of sewage disposal for the Mystic and Charles river valleys."

In becoming a part of the metropolitan system, the proportionate liability incurred by said addition shall be assumed by the town of Wakefield, and any authority granted to other municipalities in said act, or amendments thereto, is hereby also vested in said town of Wakefield, but limited in application to the territory comprising said addition.

SECT. 2. Said addition shall be subject to the provisions and conform with the requirements of the aforesaid act and amendments thereto, except that no apportionment for assessing the interest, sinking fund and maintenance expenses as therein provided shall be made for said addition earlier than the year nineteen hundred.

In case the sewers of said addition are connected with the outlet provided by the metropolitan sewerage commissioners prior to the year nineteen hundred, then back assessments with interest, beginning with the year in which such connection is made, and in accordance with the apportionment calculated for the five-year period next following, shall be levied on the said town of Wakefield by the treasurer of the Commonwealth.

SECT. 3. The metropolitan sewerage commissioners shall provide an outlet at the Wakefield town line in Greenwood street for the sewage of said addition, which shall connect with and become a part of the present trunk sewers of the metropolitan system, controlled by said board. In providing said outlet and connection and in receiving sewage from said addition, or any action in relation thereto, said board of sewerage commissioners shall conform with the provisions and have and exercise all the authority conferred upon them by said chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine, and amendments thereto, regarding the original system or anything relating thereto, except as herein otherwise provided.

This communication was referred to the chairman with full powers, who in due time sent the following reply: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, March 6, 1896.

LOUIS E. HAWES, *Chairman Sewerage Committee, Wakefield, Mass.*

DEAR SIR: — The following amendment is suggested to your bill, House Document No. 798, now pending before the Legislature: —

Amend section 3 in the third line by inserting after the word "addition" and before the word "which" the words "by the construction of a sewer from that point," and by inserting after the word "providing" in the fifth line the words "and constructing."

The bill should provide a fund of at least twelve thousand dollars ($12,000) (which would be the probable cost of construction of the sewer), and this would be made a part of the metropolitan sewerage loan, and provision for its payment similar to that made in chapter 294, Acts of 1895, should be made, with like provision for its apportionment upon the cities and towns in that system.

If this act should provide for the immediate construction of this sewer, the apportionment for assessing the interest, sinking fund and maintenance expenses should commence at once and be provided for in the act, and should not be deferred until the year 1900.

Very truly yours,

(Signed) HOSEA KINGMAN,
Chairman.

To this the following reply was received: —

BOSTON, MASS., March 24, 1896.

HOSEA KINGMAN, Esq., *Chairman Metropolitan Sewerage Commissioners.*

DEAR SIR: — Inclosed please find a copy of section 2 of the Wakefield act, as revised by the Melrose folks. The amount of the appropriation is not yet determined. Aside from that, can we say to the drainage committee of the Legislature that you approve the bill as now prepared?

Yours very respectfully,

(Signed) LOUIS E. HAWES.

SECT. 2. The metropolitan sewerage commissioners shall provide an outlet at the Wakefield town line in Greenwood street for

the sewage of said addition, and the present sewer constructed by the town of Melrose through Wyoming avenue, Berwick, Grove, Myrtle, Essex and Tremont streets to Lake avenue shall become and is hereby made a part of the main trunk line of sewers belonging to the metropolitan system. The town of Melrose shall be reimbursed by the metropolitan sewerage commissioners for the cost of construction of the same; and the metropolitan sewerage commissioners shall at once extend the said main sewer line to the Wakefield town line by constructing a main sewer through Tremont street, Melrose, Belmont, Franklin and Greenwood streets; and the town of Melrose shall have the right to maintain and make house connections with the said main sewers and connect lateral sewers therewith in the same manner as with the present sewers of the town. In providing said outlet and in taking said sewer line constructed by Melrose, and in constructing a sewer through Melrose to the Wakefield town line, and in receiving sewage from said addition and said town of Melrose, and in any action in relation thereto, said board of sewerage commissioners shall conform with the provisions and have and exercise all the authority conferred upon them by chapter four hundred and thirty-nine of the acts of eighteen hundred and eighty-nine, and amendments made thereto, regarding the original system or anything relating thereto, except as herein otherwise provided.

This Board through its chairman replied as follows: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, March 25, 1896.

LOUIS E. HAWES, Esq., *75 State Street, Boston, Mass.*

MY DEAR SIR: — Yours inclosing change in the Wakefield proposed bill duly received. You say the inclosed is a revision of section 2. I think you must mean section 3. There are several serious objections to the proposed changes in that section. There is no provision made for any taking by purchase or otherwise of the sewer constructed by Melrose or for compensation to Melrose therefor, and no provision for determining the amount of such compensation either by agreement, or other method in case of failure to agree. The proposed change imposes upon the Metropolitan Sewerage Commission the burden of paying for this sewer constructed by Melrose. Now, personally I do not want that sewer, and much less do I wish to be asked by an act of the Legislature to pay for it. There should be some provision somewhere

in the act proposed making such appropriation as may be necessary to carry out the purpose of the act. Again, your proposed change would make the Melrose sewer a part of the metropolitan system (a trunk sewer), and yet so far as its use and connections therewith are concerned leaves it entirely within the jurisdiction and control of the town of Melrose (a town sewer).

Very truly yours,

(Signed) Hosea Kingman,
Chairman.

Chapter 414, Acts of 1896, resulted from these efforts, but the amount (thirty thousand dollars) therein appropriated for the work is estimated by our engineer to be too small by five thousand dollars (see his report), and we would respectfully recommend that that amount be authorized in addition. The amount expended to date is $125.98.

Pump Tests.

At the meeting of Oct. 19, 1895, the chief engineer presented to the Board the following communication: —

The Edward P. Allis Company, Milwaukee, Wis., Oct. 10, 1895.

Metropolitan Sewerage Commission,
Mr. Wm. M. Brown, Jr., *Chief Engineer,*
110 Boylston Street, Boston, Mass.

Dear Sir: — As you are aware, our Mr. Lewis has been engaged in making preliminary tests of our engines and boilers at the East Boston station, and it is probable that in the near future we shall be ready for an official test of the machinery. In this connection we would suggest that, as the engines and pumps are exact duplicates, both at Deer Island and East Boston, the expense can be very much reduced, and the interruption of the service would be very much less, if one engine at one of the stations be selected for the official test; and we would suggest East Boston as being the most convenient place to make the test, on account of its ready accessibility as compared with Deer Island.

The question of location of weir is one that should be carefully considered, as we believe the weirs used in the capacity tests, while necessarily arranged as they were, did not give the engines credit for the actual head which they were working against; and, if the weirs are to be located in the same positions, arrangements should

be made for measuring the head against the pumps at some point nearer the pumps, so as to get at the actual resistance. In our opinion, however, it is entirely unnecessary to have a weir at all for making the *duty trials*, for the reason that the capacity tests previously made have established the speed necessary to deliver the contract quantity of water against the contract head; consequently, if the engines are operated at the speed which was found necessary to deliver the quantity, and against the contract head, the quantity of water delivered will be exactly the same as shown by the capacity test. In other words, the previous tests show that it required about eighty revolutions per minute to deliver seventy cubic feet of water per second against a head of fifteen feet; consequently, if the engines are operated at eighty revolutions per minute against fifteen feet head, the quantity of water delivered will be seventy cubic feet per second. (The above figures are close approximations only, and to determine the exact speed would require averaging the capacity tests previously made.) The above method is accurate for centrifugal pumps, for the reason that there are no plungers to leak or valves to give out, the quantity of water depending entirely on the speed of the pump wheel and height to which the water is raised.

The advantage of making tests in this way would be that there need be no interruption of the service, which would be necessary in pumping over a weir, it simply being necessary to supply the proper amount of water for the pumps. In this connection we would say that so far our Mr. Lewis has been unable to get as reliable figures as we would like to have, on account of the lack of water necessitating very short trials, and we should have sufficient water supplied to the sewer to enable the engines to be run at the rate of seventy cubic feet per second for at least twelve hours, and we trust we will be able to make arrangements to do this for Mr. Lewis.

Yours truly,

(Signed) The Edward P. Allis Company,
By Irving H. Reynolds.

At the meeting of Oct. 26, 1895, the Board

Voted, That a test be made by the Allis Company of all pumps at East Boston and Deer Island, and the expense of the same charged to the appropriation for maintaining the north metropolitan system.

The Allis Company was duly notified, as will appear by the following communication: —

The Edward P. Allis Company, Milwaukee, Wis., Oct. 31, 1895.

Metropolitan Sewerage Commission,
Mr. Wm. M. Brown, Jr., *Superintendent,*
110 Boylston Street, Boston, Mass.

Dear Sir: — We are in receipt of yours of October 29, and note that you have decided to run each of the four pumps under the full contract test. We will accordingly get all of the engines in condition for testing, and when ready will notify you.

In the mean time, we will ask what provision you propose to make for measuring the amount of water pumped at the different stations. We would suggest that the weirs be placed on the main line of the discharge, as the previous arrangements of weirs were unsatisfactory to us, and we believe did not give us the credit to which we were entitled.

Yours truly,
(Signed) The Edward P. Allis Company,
By Irving H. Reynolds.

At the meeting of Dec. 28, 1895, the engineer, reporting on certain matters connected with tests of the pumps at the various stations, was directed to proceed with said tests as speedily as possible.

The following telegram was laid before the Board at its meeting on Feb. 15, 1896: —

Milwaukee, Wis., Feb. 11, 1896.

Metropolitan Sewerage Commission, 110 Boylston Street, Boston.

We respectfully protest that further capacity tests are wholly unnecessary. We do not understand that the capacity of the pumps is in question, as the former tests of your engineers and the present duty trials show there is no doubt of their being fully up to guaranteed capacity.

The Edward P. Allis Company.

Upon the recommendation of the engineer that the capacity tests of these engines already made have demonstrated that they fully meet the contract requirements, it was

Voted, That no further capacity tests be made.

The Allis Company was notified of this decision, as will be seen by the following communication : —

The Edward P. Allis Company, Milwaukee, Wis., Feb. 15, 1896.

Metropolitan Sewerage Commission,
Mr. Wm. M. Brown, Jr., *Superintendent,*
110 Boylston Street, Boston, Mass.

Dear Sir : — We are in receipt of your telegram of the 15th, saying "Board voted to omit further capacity tests Deer Island and East Boston." We are pleased to note this, as it will facilitate the completion of the remaining tests, and we could see no necessity for repeating the capacity tests. We trust you will complete the arrangements for the duty tests at Deer Island as early as possible.

Yours truly,
(Signed) The Edward P. Allis Company,
By Irving H. Reynolds.

At the meeting of April 18, 1896, Wm. M. Brown, Jr., superintendent, submitted reports upon capacity and duty trials of pumping plants at Deer Island and East Boston pumping stations (see engineer's report), which were accepted and placed on file. These reports, showing that the bonus under the contract in each case was more than earned, the Board

Voted, To accept said plants and pay the bonus thereon.

The Board thereupon approved the balance due the contractors upon the pumping plants at Deer Island and East Boston, less ten per cent. of the value thereof, which by the terms of the contract they are authorized to hold for one year to cover any necessary expenses for repairs, together with the bonus, $10,000 at East Boston pumping station and $8,000 at the Deer Island station. The ten per cent. reserve in each case amounts to $4,700, and is held under the following clauses : —

Sect. S. The contractor hereby further agrees that the said board is hereby authorized to retain out of the moneys payable to the contractor, under this agreement, the sum of ten per cent. remaining due on the amount of the contract, and to expend the same in the manner hereinafter provided for in making such repairs of the plant as the engineer may deem expedient.

Sect. T. The contractor further agrees that if, at any time during a period of one year from the date of the final completion of the work contemplated in this contract, any part of said work shall, in the opinion of the said engineer, require repairing, and the said engineer shall notify the said contractor, in person or by mail, to make the repairs so required; and that if the said contractor shall neglect to make such repairs, to the satisfaction of the said engineer, within reasonable time from the date of giving or mailing of such notice to the said contractor, his agent or attorney, then the said engineer shall have the right to employ such other person or persons as he may deem proper to make the same; and the said board shall pay the expenses thereof out of the sum retained for that purpose by it as before mentioned. And the said board further agrees, upon the expiration of the said period of one year, provided that the said work shall at that time be in good order, that the said contractor shall be entitled to receive the whole or such part of the sum last aforesaid as may remain after the expense of making the said repairs, in the manner aforesaid, shall have been paid therefrom.

At the meeting of June 20, 1896, the engineer submitted a report upon the tests of the pumping plant at the Charlestown pumping station (see engineer's report), showing that the contractor was entitled to the full amount of bonus, and the same was accepted and placed on file. The Board then

Voted, To accept the pumping plant erected by the Edward P. Allis Company at the pumping station, Charlestown, and to pay them the full amount of bonus thereon.

The contract for the pumping plant at this station amounted to $35,000, and contained the clauses above quoted, relating to the other pumping stations, authorizing the Board to withhold ten per cent. ($3,500) for one year, to cover necessary repairs. The Board accordingly approved the bonus allowed ($3,000), together with the balance due the contractor, reserving said ten per cent. ($3,500). These reservations ($12,900 in all) due the Allis Company will be payable in April and June, 1897, less any necessary expenses mean time. At its meeting on Sept. 5, 1896, upon recommendation of the chief engineer, the Board voted to authorize the running of the several pumping stations continuously thereafter, the operations up to that time having covered only portions of the twenty-four hours each day.

Connections with the Metropolitan Sewer on this System.

In our last annual report (pages 27–30) thirty-one connections were shown as having been made to Oct. 1, 1895. During the year ending Sept. 30, 1896, twenty-six connections were authorized upon this system, as shown in the following table: —

Connections with North Metropolitan Sewer, authorized for the Year ending Sept. 30, 1896.

Date authorized.	City or Town.	Location of Connection.	Size.	Date of Completion.
May 25, 1895,	Woburn,	Canal and Lake streets,	15" pipe,	Oct. 9, 1895.
Sept. 14, 1895,	Boston,	Orleans and Decatur streets, East Boston,	16" pipe,	To be made.
Aug. 10, 1895,	Cambridge,	Willard Street, at Mt. Auburn Street,	12" pipe,	Oct. 11, 1895.
Oct. 12, 1895,	Winthrop,	Shirley Street, Short Beach,	10" pipe,	Oct. 29, 1895.
Sept. 7, 1895,	Woburn,	In private land for Baeder-Adamson & Company, glue works, through settling tanks,	8" pipe,	Nov. 9, 1895.
Oct. 4, 1895,	Cambridge,	Near Concord Avenue, for Niles Bros., slaughtering establishment,	8" pipe,	Nov. 30, 1895.
Oct. 4, 1895,	Cambridge,	Mt Auburn and Hawthorne streets,	18" pipe,	Dec. 12, 1895.
Nov. 30, 1895,	Winchester,	275 feet south of Swanton Street, Station 5+11 20, Section 45,	15" pipe,	Dec. 21, 1895.
Sept. 7, 1895,	Medford,	On Mystic Avenue, at the end of Section 35,	20" pipe,	Jan. 6, 1896.
Nov. 9, 1895,	Somerville,	On Mystic Avenue, at Moreland Street,	12" pipe,	Mar. 21, 1896.
Nov. 30, 1895,	Boston,	Butler Avenue, Orient Heights, East Boston,	12" pipe,	Jan. 23, 1896.
April 25, 1896,	Somerville,	Corner Mystic and Winthrop avenues,	30" brick,	May 29, 1896.
March 14, 1896,	Cambridge,	Dunster Street,	12" pipe,	June 1, 1896.
May 9, 1896,	Arlington,	At the end of metropolitan sewer in Decatur Street,	18" pipe,	June 20, 1896.
March 14, 1896,	Cambridge,	Corner Dyke and Plympton streets,	30" pipe,	June 30, 1896.
May 16, 1896,	Somerville,	Corner Rowland and Waverly streets,	24" pipe,	July 21, 1896.
June 6, 1896,	Stoneham,	At the end of the metropolitan sewer, at Montvale Avenue,	15" pipe,	To be made.
July 1, 1896,	Medford,	Boston Avenue,	8" pipe,	July 23, 1896.
Oct. 19, 1895,	Cambridge,	Brookline Street, near Cottage Farm Station, Boston & Albany Railroad,	10" pipe,	Aug. 1, 1896.

Connections with North Metropolitan Sewer, etc. — Concluded.

Date authorized.	City or Town.	Location of Connection.	Size.	Date of Completion.
May 23, 1896,	Boston,	Condor Street, near Meridian Street, East Boston,	15″ pipe,	Aug. 14, 1896.
Aug. 1, 1896,	Boston,	A. B. Heath, Institutions Commissioner, Deer Island, about Station 12+80,	8″ pipe,	Aug. 21, 1896.
Aug. 1, 1896,	Winchester,	On the westerly side of the metropolitan sewer, in the Mystic valley parkway, at man-hole,	18″ pipe,	Aug. 25, 1896.
July 22, 1896,	Cambridge,	In private land near Alewife Brook, east of Massachusetts Avenue (Tannery Brook connection),	15″ pipe,	Aug. 28, 1896.
March 14, 1896,	Cambridge,	Pearl Street,	20″ brick,	Aug. 31, 1896.
Sept. 5, 1896,	Melrose,	Corner of Gould and Pleasant streets,	15″ pipe,	Sept. 25, 1896.
Aug. 1, 1896,	Boston,	About 200 feet south of shaft at the southerly end of siphon at man-hole in Alford Street, in the park,	15″ pipe,	To be made.

The fifty-four connections made on this system to this date (Oct. 1, 1896) are distributed as follows: Arlington, two; Belmont, one; Boston, three; Cambridge, thirteen; Everett, two; Malden, four; Medford, eleven; Melrose, two; Somerville, three; Winchester, seven; Winthrop, three; and Woburn, three. The Board has authorized at this date nine connections, which have not been made as yet, distributed as follows: Boston: East Boston, two; Deer Island, one; Cambridge, four; Medford, one; Stoneham, one.

Expenditures.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1896, amount to $400,349.58. This, with the amount previously reported, $4,556,204.92, makes the total expenditures to date $4,956,554.50. Table D in the Appendix contains a full statement of the cost of operation for the year ending Sept. 30, 1896. Your attention is called to the tables submitted herewith for matters of detail.

CHARLES RIVER VALLEY SYSTEM.

The operation of this system has been constant during the year, and a full statement of the expenses is in Table E in the Appendix. The unexpended balance on Sept. 30, 1896, will, we estimate, be sufficient to meet operating expenses until such time as a new appropriation can be made therefor.

In our last annual report (Public Document No. 45, 1896), after outlining the negotiations then pending in relation to a new contract with the city of Boston, in relation to receiving sewage from the Charles River valley system, we say: —

> On Saturday, Feb. 9, 1895, the superintendent of streets met the Board by appointment, and stated that the subject of receiving sewage from the Charles River valley system was being investigated, and would be reported upon at as early a day as possible. There the matter has rested, and negotiations are still pending, with this end in view.

In November, 1895, the Board addressed the following letter to the superintendent of streets of the city of Boston: —

> Commonwealth of Massachusetts,
> Metropolitan Sewerage Commissioners, 110 Boylston Street,
> Boston, Nov. 30, 1895.
>
> B. T. Wheeler, Esq., *Superintendent of Streets, City Hall, Boston, Mass.*
>
> Dear Sir: — Will you kindly meet this Board in consultation in relation to the contract for disposal of sewage from the Charles River valley system, through the Boston Main Drainage Works, with outlet at Moon Island, on Saturday next, December 7, at 10 o'clock A.M., at their office, No. 110 Boylston Street, Room 21?
>
> For the Board,
> Truly yours,
> (Signed) Edward P. Fisk,
> *Clerk.*

To this the following reply was received : —

STREET DEPARTMENT, CITY HALL,
OFFICE OF THE SUPERINTENDENT, ROOM 47,
BOSTON, Dec. 3, 1895.

Mr. EDWARD P. FISK,
Clerk Metropolitan Sewerage Commission, 110 Boylston Street.

DEAR SIR : — I will endeavor to be at your office Saturday next, December 7, at 10 A.M , if possible.

Very truly yours,

(Signed) B. T. WHEELER,
Superintendent of Streets.

On Dec. 7, 1895, as appointed above, B. T. Wheeler, superintendent of streets, and others of the city of Boston, held a consultation with the Board regarding the price to be paid Boston for receiving sewage from the Charles River valley system and disposing of the same at Moon Island for a period of five years (1896 to 1900 inclusive), but failed to reach any conclusion in the matter.

On Nov. 9, 1895, the following certificate had been sent to the Treasurer and Receiver-General : —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, Nov. 9, 1895.

To the Treasurer of the Commonwealth of Massachusetts.

The Board of Metropolitan Sewerage Commissioners, in pursuance of the requirements of section 13 of chapter 439 of the Acts of 1889, do hereby certify that they estimate the cost of the maintenance and operation of the system of sewage disposal for the cities of Boston, Newton and Waltham, and the towns of Brookline and Watertown (called by us the Charles River valley system), as follows : —

Item 1.	For the year 1896, ...	$30,000 00
Item 2.	For the year 1897, ...	31,000 00
Item 3.	For the year 1898, ...	32,000 00
Item 4.	For the year 1899, ...	33,000 00
Item 5.	For the year 1900, ...	33,500 00

HOSEA KINGMAN,
TILLY HAYNES,
ALBERT F. NOYES,
Metropolitan Sewerage Commissioners.

(Signed) By EDWARD P. FISK,
Clerk.

The officials of the city of Boston had been demanding more than $60,000 annually for service which had been previously rendered for about $25,000 annually, and at the meeting above referred to the superintendent of streets had agreed to review his figures and report to the Board upon the same, there being a wide discrepancy between his figures and the estimates of our engineer, as reported to the Treasurer and Receiver-General in the communication of Nov. 9, 1895. The following correspondence passed between the superintendent of streets and this Board in relation thereto: —

STREET DEPARTMENT, CITY HALL,
OFFICE OF THE SUPERINTENDENT, ROOM 47,
BOSTON, Jan. 4, 1896.

Metropolitan Sewerage Commission, 110 Boylston Street.

GENTLEMEN: — Since the hearing kindly accorded me before your Board in the matter of the rental to be paid by the State to the city of Boston for the use of its sewers and main drainage works, I have carefully reconsidered all the points made, as I promised, and beg to submit the following conclusions, in which I think I have yielded every point which I consistently could, and have practically covered, I believe, all of those objections which I understood your Board to make.

You will remember that, upon the basis of actual measurements taken, we estimated the flow of sewerage to be 20+ cubic feet per second, while your engineer, I believe, not from actual measurements, theoretically figured it to be 16+ cubic feet per second. I have since submitted to your Mr. Swan a calculation based upon the Board of Health's estimate of sewage and population, which makes the flow 18.6 cubic feet per second. As this has been in Mr. Swan's hands nearly two weeks, and as I have received no reply from him or you, although I have communicated with your Board by telephone regarding the matter, I assume that such a fair mean between your estimate and our measurement as this is, based upon such authentic sources, cannot help but meet with your approval. Upon this basis, the following tables show the sum to be paid the city by the State on the three following items: —

1. Maintenance.
2. Total expenditure at 3.987 per cent, consisting of two parts, viz.: —

Interest up to 1892, ...	$1,204,932 12
Interest on expenditure since 1892, figured to 1896,	25,260 56
	$1,230,192 68

3. Interest at 3.987 per cent. on total expenditure to 1896.

Total expenditure to 1896, ... $4,503,027 61

In tables A, B and C the amounts to be paid by the State are on the basis that the State pays for pumping the sewage of Brighton and part of Boston above Gainsborough Street. In tables D, E and F the amounts to be paid are on the basis that the State pays for pumping the sewage of the Charles River towns, exclusive of Brighton, and part of Boston above Gainsborough Street.

TABLE A. — *Maintenance.*

YEAR.	Total Gals. per Day to be pumped.	Total Gals. per Day to be pumped for State.	Ratio.	Cost per Million Gals. pumped Daily.	Total Cost of Pumping.	Amount to be paid by State.
1896, ...	67,200,000	12,800,000	4/21	$1,551 18	$104,239 30	$19,855 10
1897, ...	71,700,000	13,500,000	45/239	-	111,219 61	20,940 93
1898, ...	76,100,000	14,200,000	142/761	-	118,044 80	22,026 76
1899, ...	80,600,000	14,900,000	149/806	-	125,025 11	23,112 58
1900, ...	85,100,000	15,700,000	157/851	-	132,005 42	24,353 53

TABLE B. — *Interest.*

YEAR.	Interest on $1,230,192.68, at 3.987 Per Cent.	Ratio.	Amount to be paid by State.
1896, ...	$49,047 78	4/21	$9,342 43
1897, ...	-	45/239	9,234 94
1898, ...	-	142/761	9,152 15
1899, ...	-	149/806	9,067 14
1900, ...	-	157/851	9,048 77

TABLE C. — *Summary.*

YEAR.	Interest on $4,503,027.61, at 3.987 Per Cent.	Ratio.	Amount to be paid by State.	Total of Items 1, 2 and 3.	Round-out of Items = Total Amount to be paid by State.
1896, ...	$179,535 71	4/21	$34,197 28	$63,394 81	$63,000 00
1897, ...	-	45/239	33,803 79	63,979 66	64,000 00
1898, ...	-	142/761	33,500 75	64,679 66	64,500 00
1899, ...	-	149/806	33,189 60	65,369 32	65,500 00
1900, ...	-	157/851	33,122 33	66,524 63	66,500 00

TABLE D. — *Maintenance.*

YEAR.	Total Gals. per Day to be pumped.	Total Gals. per Day to be pumped for State.	Ratio.	Cost per Million Gals. pumped Daily.	Total Cost of Pumping.	Amount to be paid by State.
1896, . . .	67,200,000	8,900,000	886/6,720	$1,551 18	$104,239 30	$13,743 45
1897, . . .	71,700,000	9,300,000	932/7,170	-	111,219 61	14,456 99
1898, . . .	76,100,000	9,800,000	98/761	-	118,044 80	15,201 56
1899, . . .	80,600,000	10,300,000	103/806	-	125,025 11	15,977 15
1900, . . .	85,100,000	10,700,000	107/851	-	132,005 42	16,597 63

TABLE E. — *Interest.*

YEAR.	Interest on $1,230,192.68, at 3.987 Per Cent.	Ratio.	Amount to be paid by State.
1896, ...	$49,047 78	886/6,720	$6,466 72
1897, ...	-	932/7,170	6,375 52
1898, ...	-	98/761	6,316 27
1899, ...	-	103/806	6,267 89
1900, ...	-	107/851	6,166 99

TABLE F. — *Summary.*

YEAR.	Interest on $4,503,027 61, at 3 987 Per Cent.	Ratio.	Amount to be paid by State.	Total of Items 1, 2 and 3.	Round-out of Items = Total Amount to be paid by State.
1896, ...	$179,535 71	886/6,720	$23,670 93	$43,881 10	$43,500 00
1897, ...	-	932/7,170	23,337 14	44,169 65	44,000 00
1898, ...	-	98/761	23,120 24	44,638 07	44,500 00
1899, ...	-	103/806	22,943 15	45,188 19	45,000 00
1900, ...	-	107/851	22,573 82	45,338 44	45,500 00

You will note that I have submitted two estimates, because of the fact that, since our last interview, your Mr. Brown has stated that a portion of the previous rental paid was assessed back upon the city, of which we were unaware, and because our previous estimate made to you this year did not include the total area drained by the metropolitan system, but excluded Brighton and the part of Boston above Gainsborough Street. I cannot understand how this could have been the case, since I supposed all previous figures made to have been upon a district which did not include these parts of Boston. If the rental, therefore, is to

include all areas entering into the metropolitan system, and thence into our main drainage works, the rental we ask will be the larger figures named. If the rental is to be for the territory outside of Boston entering the metropolitan system, and thence our main drainage works, the rental will be the smaller figures.

I think that, with a feeling of perfect fairness, I have yielded all those points which I can; and in regard to some of your claims made at our interview, I wish to say that the corporation counsel informs me that at the time when the city agreed to the previous rental it was distinctly understood between the commissioners, Mr. Carter and himself that the rental then charged was not an adequate one, and was not to serve as any precedent. The city yielded its claims to increase from the fact that the commission stated at that time that it had made its estimate to the auditor, and would be much embarrassed by an increase.

With regard to your claim that the rates of interest at which the State could have hired money at the time when the city made loans to build this plant were less than those actually paid by the State, I find that this has no great foundation, since in 1875, 1876 and 1877 the State paid 5 per cent. upon its bonds, and is now paying 3 and $3\frac{1}{2}$ per cent.

Regarding your statement that the State could, and might, take the plant belonging to the city, and that, if it did so, the amount paid therefor would not be the cost of that plant to date; that it had unquestionably deteriorated; and that it could be built to-day for a less sum than it originally cost, — I have nothing to say, except that I know of no facts to bear out this statement; and if the State chooses, rather than pay what appears to me to be a fair rental, to take the plant, as the commission has intimated, I am of the opinion (and the corporation counsel coincides with me in this) that the payment to be made therefore by the State will not differ materially from the cost of said plant to the city of Boston.

Very truly yours,

(Signed) B. T. Wheeler,
Superintendent of Streets.

To this the following reply was mailed: —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, Jan. 11, 1896.

B. T. Wheeler, Esq.,
Superintendent of Streets, Boston, Mass.

Dear Sir: — Your communication of Jan. 4, 1896, to the Metropolitan Sewerage Commissioners, relating to their contract with the city of Boston for disposal of sewage from Charles River

areas, through Boston main drainage works, was this day considered. In reply, it is desired to state that in the matter of flow of sewage under consideration you appear to misunderstand the facts. The estimate of 16 cubic feet per second by our engineer was based upon actual measurements extending over a considerable period of the spring of 1894. Your estimate of 20 cubic feet per second, we understand, was obtained from measurements of a few hours, extended to cover a single day, from ratios obtained from the actual measurements of our engineer, as set forth in report to you from H. W. Sanborn, deputy superintendent sewer division, dated Nov. 11, 1895. Measurements for so short a time and made possibly under unusual conditions of flow could not equitably be applied to flows extending over a whole series of years.

In relation to your second estimate of flow of 18.6 cubic feet per second, the facts are as follows: your Mr. Dorr had an interview with our engineer about Dec. 19, 1895, in relation to the proposed study, in which a variety of allowances and uses of the sewers was considered. The result of this interview was that your Mr. Hamilton was to carry out a series of calculations, on the completion of which a conference was to be had between your engineer and our own. Our Mr. Swan met your Mr. Hamilton December 20 in relation to the calculations. We were notified by telephone December 31 that your people were prepared for a conference, and a conference was arranged for your Mr. Dorr at the office of our engineer, Jan. 3, 1896. He, however, failed to appear, and no further appointment had been made prior to the receipt of your communication of Jan. 4, 1896.

Your second estimate of flow, based upon the State Board of Health's estimate of sewage and population, giving 18.6 cubic feet per second, is regarded by us as being worthy of detailed examination. This method, as we understand it, was based upon the estimated average water consumption, to which was to be added for ground water, etc., an amount estimated at 52 gallons per day per inhabitant. This amount is regarded by us as excessive, for the following reasons: —

In the report of the State Board of Health, from which your estimate was derived (viz., report of January, 1889, Senate No. 2), on page 92 is an estimate of the average rate of flow of sewage per inhabitant in Boston, as follows: —

	Gallons.
Sewage equal to the water supply,	90
Sea-water leakage,	8
Sea-water leakage from sugar refinery,	4
Ground water,	45
	147

It appears to us, therefore, that your figure for ground water, etc. (viz., 52 gallons), must include about 7 gallons of sea water, which is nearly equal to the amount of sea-water leakage in the above estimate. Now, it is evident that the opportunity for the leakage of sea water in the case of the sewers in the Charles River valley is very much less than it is in the case of the sewers in Boston, since the greater part of the territory in the former case is above the level of the sea. Moreover, we are of the opinion that the amount of leakage of ground water proper in the Charles River valley district is less than it is in Boston, for the reason that special provision has been made in some parts of said valley to reduce the level of the ground water.

For these reasons it appears to us that the estimate for ground water, etc., should be reduced say to 45 gallons per inhabitant per day, as in the above estimate. With this amount the estimated daily average flow of sewage is about 3.4 per cent. more than the estimate formerly made by this Board for the period under consideration. The estimate of population of the Metropolitan Water Board is about 10 per cent. greater than the estimate made by the Board for the period under consideration. These two percentages when combined indicate that an increase of about 13.74 per cent. over the estimate of sewage made by this Board would result from using this method, here suggested, based upon 45 gallons per inhabitant per day in addition to the estimated daily average water consumption.

We are still of the opinion that interest charges should be shared on the use of the system. The Charles River main is designed and used for foul drainage only. The very careful study of the State Board of Health (see report, January, 1889, Senate No. 2, page 97) indicates that fully 50 per cent. of the capacity of the trunk sewer and outfall works of Boston main drainage have been, and for the coming thirty years probably will be, devoted to storm-water relief for city of Boston areas. Under these conditions it has seemed to us that the Charles River area should pay their proportional part of interest charges on only 50 per cent. of the cost of the works, and the Commonwealth should not pay for the use of the city sewer and outfall works any sum by way of interest on such sum of money as the city has paid by way of interest on the money it borrowed to construct the sewer and outfall works.

You suggest that the cost to the Charles River areas could not be less than the amounts arrived at in your study, if the Sewerage Commission should acquire and operate the works. A hasty study has been prepared to indicate costs to Charles River areas on the basis of last award of apportionment commission, as follows: —

Combined Works, — Charles River Valley Sewer and Boston Main Drainage.

Proportions based upon Valuations of 1895.

CITY OR TOWN.	Estimated Valuations.*	Estimated Proportions.†		
		Combined District as a Whole.	As between the Present Charles River Valley Group and the Boston Main Drainage.	
		Per Cent.		Per Cent.
Boston,	$914,214,378	86.33	B.M.D.	81.33
			C.R.V. 5.00	
Brookline,	66,550,308	6.28	C.R.V. 6.28	18.67
Watertown,	8,706,146	0.82	C.R.V. 0.82	
Newton,	49,969,044	4.72	C.R.V. 4.72	
Waltham,	19,584,719	1.85	C.R.V. 1.85	
	$1,059,024,595	100.00		100.00

* Of districts tributary to Charles River valley sewer and Boston main drainage.

† In which the several cities and towns may be called upon to pay money to meet interest and sinking fund requirements.

Proportions based upon Populations of 1895.

CITY OR TOWN.	Estimated Populations.*	Estimated Proportions.†		
		Combined District as a Whole.	As between the Present Charles River Valley Group and the Boston Main Drainage.	
		Per Cent.		Per Cent.
Boston,	405,936	84.86	B.M.D.	78.59
			C.R.V. 6.27	
Brookline,	16,159	3.38	C.R.V. 3.38	21.41
Watertown,	7,788	1.63	C.R.V. 1.63	
Newton,	27,622	5.77	C.R.V. 5.77	
Waltham,	20,877	4.36	C.R.V. 4.36	
	478,382	100.00		100.00

* Of districts tributary to Charles River valley sewer and Boston main drainage.

† In which the several cities and towns may be called upon to pay money to meet cost of maintenance and operation.

Maintenance.

YEAR.	Total Gals. per Day to be pumped. (Street Dept.)	Total Cost of Pumping, etc., B.M.D. (Street Dept.)	Cost of Maintenance, Charles River Valley Sewer.	Total Combined Maintenance.
1896,	67,260,000	$112,600 99	-*	-*

* The cost of maintenance of Charles River valley sewer is offset by the cost of maintenance of the branch intercepting sewers in Boston, which is understood to be included in column 3.

YEAR.	Ratio for Charles River Valley Group.	Amount to be paid by Charles River Valley Group.
	Per Cent.	
1896,	21.41	$24,107 87
1897,	21.41	25,722 23
1898,	21.41	27,300 73
1899,	21.41	28,915 09
1900,	21.41	30,529 46

The Charles River valley group comprises Waltham, Newton, Watertown, Brighton, Brookline and "part of Boston."

The amounts given in the estimates received from the Boston street department, sewer division, are assumed to be correct for the purposes of this table.

The estimated annual cost of maintenance, interest and sinking fund for the Charles River valley sewer is $30,670.39.

TABLE 1*b*.

YEAR.	Payments to Interest and Sinking Fund.*	Payments to Metropolitan Sewerage.†	Total Payments Interest and Sinking Funds.	Ratio for the Charles River Valley Group.
				Per Cent.
1896,	$179,415 00	$25,670 39	$205,085 39	18.67
1897,	179,415 00	25,670 39	205,085 39	18.67
1898,	179,415 00	25,670 39	205,085 39	18.67
1899,	179,415 00	25,670 39	205,085 39	18.67
1900,	179,415 00	25,670 39	205,085 39	18.67

* On account of estimated cost of purchase of portions of the Boston main drainage, $4,500,000 at 3.987 per cent.

† Interest and sinking fund for Charles River valley sewer, $769,726.72 at 3.335 per cent.

YEAR.	Amounts to be Paid by the Charles River Valley Group.			Amounts.*
	For Interest and Sinking Fund.	For Maintenance.	Total.	
1896,	$38,289 44	$24,107 87	$62,397 31	$31,726 92
1897,	38,289 44	25,722 23	64,011 67	33,341 28
1898,	38,289 44	27,300 73	65,590 17	34,919 78
1899,	38,289 44	28,915 09	67,204 53	36,534 14
1900,	38,289 44	30,529 46	68,818 90	38,148 51

* After deducting $30,670.39 from the total and equivalent to a rental to be paid city of Boston.

The amounts are some $30,000 per year less than your figures, and it is not unlikely that an apportionment commission might still further reduce them on account of Boston storm-water uses of the outfall works.

In regard to your doubt whether a portion of the cost of maintenance of the Charles River system is assessed back upon the city, we beg leave to refer you to page 36 of our fourth annual report, on which is a table giving the award of the first board of apportionment. The proportion of the expense for maintenance to be paid by the city of Boston for "Brighton and part of city proper" is there given as 25.05 per cent. of the whole cost of maintenance, which, of course, includes any rental paid by the Commonwealth to the city of Boston for disposing of the sewage. This is further made evident by the State Auditor's report for January, 1896, where, on page 137, it is seen that the city of Boston paid $6,763.50 in a total of $27,000 on account of Charles River system of sewage disposal maintenance. In regard to your contention that the rental formerly agreed upon was considered at the time to be inadequate, and that it was not to serve as a precedent, we beg to say that we understand such is not the fact. There was no contention as to the amount of yearly rental to be paid for the first three years. These amounts were agreed upon as the result of computations made by Mr. Carson and Mr. Carter. As to the yearly rental for the last year of the four years, Mr. Carter thought that, because of the increased amount of sewage which would probably be discharged that year from the Charles River system, the sum of $24,000 might perhaps not be sufficient, and reserved the right to increase that amount if, before the final execution of the contract, he should become satisfied that said sum was too small. No change in the amount was made, and the contract was executed with the city for that amount. There was no understanding on the part of the commission that the rental charged for those years was not adequate, nor that the same was not to serve as a precedent. The city did not then claim any increase except as already stated above.

For the Board,
Truly yours,
(Signed) EDWARD P. FISK,
Clerk.

To the foregoing the following reply was received: —

STREET DEPARTMENT,
OFFICE OF THE SUPERINTENDENT, ROOM 47,
CITY HALL, BOSTON, Jan. 15, 1896.

Metropolitan Sewerage Commission, 110 Boylston Street.

GENTLEMEN: — I beg to acknowledge the receipt of your communication of January 11, in reply to mine of January 4, and I trust I shall be excused for saying that you appear to shift your

ground in this matter as fast as your position seems vulnerable. This I admit to be good generalship, but it will not lead, in my judgment, to any agreement between us.

I wish also to add that two statements which I made in my communication referred to, in support of which I can bring witnesses, are stated courteously by you not to be facts. Your mere statement to the contrary does not bear any more weight with me than the testimony of my witnesses; and I trust the last clause of my letter of the 4th instant will excuse me from any further discussion, and be considered final.

I must also call your attention to two statements in your letter, one of which implies that the leakage of your system is very small, the reasons advanced being the fact that much the greater part of its territory is above the level of the sea, that the ground-water leakage is specially provided against, and the assumption of superior construction of your sewers. A large portion of your Charles River valley system is below the sea level, running through salt-marsh lands. I know of no special provision (of which you speak) in the matter of ground water unless your refer to the Noyes system of underdrainage, which I understand you have in some portion of Newton, and which I do not wish to criticise, except that it unquestionably gives a head to the ground water, and may perhaps be the cause of increased rather than diminished leakage.

After your system was constructed and before any connections had been made with it, there was a considerable flow through it, due to leakage entirely. I think my sewer division officials have some data in regard to the amount of this, number of cubic feet per second, and, if so, they will gladly hand this to you, if you are not already in possession of it. From this it would appear that your system was no more perfectly constructed in this regard than others.

You state that your Mr. Swan met my Mr. Hamilton December 20 in relation to calculations which I submitted for your approval or rejection, that you were notified by telephone December 31 that I was prepared for a conference, that a conference was arranged for Mr. Dorr at the office of your engineer January 3, that he failed to appear, and that no further appointment was made previous to the receipt of my communication of January 4. I desire for personal reasons to set Mr. Dorr right in this matter, and to say that no communication was received from any of your people after the conference between Mr. Swan and Mr. Hamilton; that, because of this, I personally called up your office twice, requesting that Mr. Swan return the study with any comments which he might

have to make, or with the approval of the Board; and that no conference was arranged for Mr. Dorr on January 3, or at any other date after December 20, either by Mr. Hamilton, Mr. Dorr, Mr. Sanborn or myself, or by any other person whatsoever, so far as I am able to discover.

Very truly yours,

(Signed) B. T. Wheeler,
Superintendent of Streets.

The late Governor, Frederic T. Greenhalge, in his inaugural address to the Legislature of 1896, speaks thus of —

Metropolitan Sewerage.

Since last January negotiations have been pending between the city of Boston and the Board of Metropolitan Sewerage Commissioners with a view to fixing upon the yearly rental value of the trunk sewer, pumping station and outfall of the Boston improved system for the use of our Charles River system, for a term of five years. It was hoped that some agreement might be reached. During the last five years the Commonwealth has paid the city of Boston for this use an average yearly rental of about $26,000, but now the city of Boston asks about $52,000 per year for the next five years. Under the statutes the Commonwealth can, by the exercise of the right of eminent domain, take the right to use the trunk sewer and leave the question of rental to be determined by the courts or otherwise. The same question will arise when it becomes necessary to use the Neponset valley sewer, which is soon to be constructed. It would be well to consider whether it would not be economy and good policy for the Commonwealth to take the main trunk sewer of the Boston improved system, from the point in Huntington Avenue where the metropolitan sewer connects with it to the pumping station, and take the pumping station and outfall sewer now belonging to the city of Boston as a part of the metropolitan system, and have the same thereafter maintained and operated by the Commonwealth.

There may be some question whether chapter 439 of the Acts of 1889 is broad enough in its terms to confer upon the commission the authority to take the pumping station and outfall sewer; therefore, if it should seem best to pursue this course, such legislation should be had as would give the power and provide the funds.

The above paragraph, as well as the annual report of this Board (Public Document No. 45, 1896), was referred by the Legislature to the committee on metropolitan affairs,

and a hearing was appointed to this Board on Jan. 27, 1896, regarding the same. The question of the trunk line of the Boston main drainage system being taken by the Commonwealth and incorporated as a part of the metropolitan sewerage system was held pending further investigation. On Jan. 29, 1896, the following communication, which is self-explanatory, was addressed to the committee and sent to its chairman: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, Jan. 29, 1896.

To the Committee on Metropolitan Affairs,
Hon. CHARLES F. SPRAGUE, *Chairman.*

After our meeting with you Monday, on talking the matter over together we found that there was some misunderstanding as to the question of whether this Board desired legislation; also as to whether our report asked for legislation. It is claimed that our chairman stated that our report asked for legislation as to the matters hereinafter stated. If he did so state, it was error and must have misled you. Our report speaks as of Sept. 30, 1895, but since that time conditions have changed somewhat, and we now feel that it is of importance to the cities and towns of the Charles River and Neponset valley systems that the main trunk sewer of the Boston main drainage system, from the point at Gainsborough Street, in Huntington Avenue, where the Charles River system sewer now connects with the main drainage system, to its outlet of discharge at Moon Island, the pumping station, storage basins and discharge plant and sewers, should be taken, controlled and operated by the Commonwealth, the cities and towns using the sewer and benefited thereby to pay therefor the fair market value of the property. For the past four years the Charles River system has been paying to the city of Boston for the use of said property rental at the rate of $23,000 for the first three years and $24,000 for the last year. This was done under an agreement which terminated Dec. 31, 1895. Early in 1895 negotiations were commenced for the purpose of determining rental for said property for a year or term of years, and as yet without definite result. The city of Boston claims something over $63,000 as a fair price for yearly rental of said property. Under the original act, 1889, chapter 439, the Commonwealth has the right to take the use of the sewers of the Boston main drainage system and have the sewage of the Charles River system discharged through said pumping station and said outlet at Moon Island, paying therefor such price as may

be determined by the courts or otherwise. The Neponset valley sewer must when completed also discharge into the main drainage system, and must also pay tribute to the city of Boston for the use of said property. Then we will have two systems of sewers belonging to the Commonwealth dependent upon the city of Boston and its operation and care of said property for the disposal of sewage, with every little while a question of contract or taking of the right to use said property to be open for discussion, settlement and possibly litigation. It would seem to be economy for the Commonwealth to take and own said property, as it is likely it would cost the several cities and towns less to hire the money of the Commonwealth for the purchase of said property and pay interest thereon than to pay any such sum as the city of Boston is now asking for yearly rental. If said property were so taken the expense thereof would (or could, under proper legislation) be apportioned upon the several cities and towns benefited, and so all (including Boston) bear the burden equitably and fairly. We deem the matter of sufficient importance to call your attention to it, inasmuch as the recommendations and plans of the State Board of Health referred to in said act of 1889 clearly contemplate the use of said property by said Charles River valley system and the disposal of its sewage thereby; and yet the terms of said act (it seems to us) are hardly broad enough to justify the taking of said property by the Commonwealth, and no appropriation large enough to meet such expense has ever been made.

By the last Legislature an act (1895, chapter 406) was passed authorizing this Board to construct a sewer for the Neponset River valley, and the sum of $500,000 appropriated therefor. Studies and plans for the work have been made and submitted to the State Board of Health, as required by the act. From these studies and plans it is estimated by our Board that the work will cost $675,726 (see our report, page 49). We call attention to this, not that we think it will be necessary to make an additional appropriation for this purpose this year, as the present appropriation will probably be sufficient for all the work we can accomplish in this direction this year, but that you may have a full understanding of the situation.

Very respectfully,

BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS,

(Signed) HOSEA KINGMAN,

Chairman.

Hon. Josiah Quincy, having succeeded Mayor Curtis as mayor of Boston, appointed Benj. W. Wells successor to

B. T. Wheeler as superintendent of streets, and on Feb. 19, 1896, the following communication was sent to the mayor by order of the Board: —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, Feb. 19, 1896.

Hon. Josiah Quincy,
Mayor of the City of Boston, City Hall, Boston, Mass.

Dear Sir: — On Jan. 19, 1895, this Board addressed a communication to your predecessor, calling attention to the fact that a contract made between the Commonwealth and your city in 1892 for disposing of sewage from the Charles River valley system of the metropolitan sewerage through the Boston main drainage works expired with the year 1895, and asking that some one be designated to act for the city in relation to a new contract. In answer, Mr. Wheeler, the late superintendent of streets, was named, and negotiations were pending at the time of his retirement. Mr. Wheeler had had several consultations with this Board, but no agreement had been reached, and, as this Board desires an early settlement, will you kindly designate some one to meet us in relation thereto, that the matter may be speedily adjusted?

For the Board,
Yours very truly,
(Signed) Edward P. Fisk,
Clerk.

The following was received in reply: —

Street Department, City Hall,
Office of the Superintendent, Room 47,
Boston, March 23, 1896.

Metropolitan Sewerage Commission, 110 Boylston Street.

Gentlemen: — Your letter of February 18 to His Honor the mayor, in reference to contract between the Commonwealth and the city of Boston for disposing of sewage from the Charles River valley system of metropolitan sewerage though the Boston main drainage works, has been referred to me for action. I have placed the matter in the hands of Mr. Nathan S. Brock, the engineer of construction of this department, and I should be pleased to hear from you in regard to such further arrangements as may lead to an early settlement.

Yours very truly,
(Signed) Benj. W. Wells,
Superintendent of Streets.

After further correspondence an appointment was made for Mr. Brock to meet this Board in consultation on April 11, 1896, at which time said meeting was held, and the matter of determining the relative flow in the Charles River valley sewer was referred to the engineering department of this Board, to act in concert with the street department of the city of Boston, and report later.

In answer to a request of the committee on metropolitan affairs for a bill authorizing the Commonwealth to acquire the Boston main drainage system by purchase or otherwise, and making appropriation therefor, the following was submitted to the chairman: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, March 18, 1896.

Hon. CHARLES F. SPRAGUE,
Chairman Committee on Metropolitan Affairs,
State House, Boston, Mass.

DEAR SIR: — I enclose the draft of an act prepared by this Board, covering the recommendations made by His Excellency in his annual message to the Legislature, regarding the Commonwealth's acquiring the Boston main drainage system.

Will your committee kindly authorize the same to be printed for use, so that copies may be furnished to parties interested?

For the Board,
Very truly yours,
(Signed) EDWARD P. FISK,
Clerk.

The act alluded to followed in general the provisions of chapter 406, Acts of 1895, with such alterations as were necessary to adapt it to the circumstances for which it was intended. By the committee's directions one hundred copies were printed for its use, some of which are now accessible. Early in April, at a hearing appointed by the committee on the proposed bill, a verbal agreement was entered into between this Board by its chairman and the city of Boston by its corporation counsel, with the approval of the mayor, to make the amount $27,000, to be paid said city for receiving sewage from the Charles River valley system at the connection between said system and its main drainage line

at Huntington Avenue and Gainsborough Street, Boston, and discharging the same at its outlet at Moon Island during the year 1896, the payments to be made in quarterly instalments, as under the previous contract; and, pending the investigation previously referred to regarding the flow in the Charles River valley sewer, the paragraph of the governor's address above quoted was referred to the next General Court by the Legislature then in session.

This Board has not as yet received any formal report from the city of Boston regarding the question then pending, but understands that the results of the investigation indicate that a saving of several thousand dollars annually would be made to said city by the Commonwealth's taking and acquiring the trunk line of the Boston main drainage system, and incorporating it as a part of the metropolitan sewerage system. We would respectfully ask, therefore, that the matter referred to your honorable body by its predecessor be considered and favorably acted upon.

The following settlements for land taken upon this system have been made during the year: by deed dated April 3, 1896, Mary E. Emerson, administratrix and heir-at-law of the estate of Matilda Emerson of Newton, quit-claimed to the Commonwealth "rights, privileges and easements" in land in Newton, included in a taking dated March 7, 1891, and recorded in Middlesex South District Registry, book 2030, page 121. The deed from the said Emerson is recorded with Middlesex South District Registry, book 2457, page 565. Damages sustained to land in Brighton and Newton, belonging to John E. Cassidy, included within a taking dated March 7, 1891, and recorded in Suffolk Registry of Deeds, book 1987, page 3, and also in Middlesex South District Registry, book 2030, page 121, were paid by the Commonwealth upon an execution issued from the superior court; and Walter U. Lawson of Newton was similarly satisfied for land in Newton taken under the aforesaid taking.

This leaves the following cases on this system still pending in court at this date (Oct. 1, 1896): Suffolk County, Butchers' Slaughtering and Melting Association; Middlesex County, Albert Breckett, Newton.

Connections made with the Metropolitan Sewer in the Charles River Valley from Oct. 1, 1895, to Sept. 30, 1896.

Date authorized.	City or Town.	Location of Connection.	Size.	Date of Completion.
Oct. 26, 1895, .	Newton,	In garden of Sarah M. L. Bates, near Hyde Brook.	5 inch,	Nov. 4, 1895.
May 2, 1896, .	Newton,	In land of estate of Matilda Emerson, east of Hyde Brook.	6 inch,	May 18, 1896.

These, with the connections previously reported, show thirty-five connections made with the metropolitan sewer by the towns and cities embraced within this system, which are distributed as follows: Boston, nine; Brookline, one; Boston (Brighton), twelve; Watertown, four; Newton, eight; Waltham, one; total, thirty-five.

Watertown Siphon.

The following letter received by the Board was referred to the engineer at its meeting held Feb. 1, 1896: —

Commonwealth of Massachusetts,
Metropolitan Park Commission, Engineering Department,
13 Exchange Street, Boston, Jan. 31, 1896.

Hosea Kingman, Tilly Haynes, Albert F. Noyes,
Metropolitan Sewerage Commissioners.

Gentlemen: — In compliance with the instructions received from a committee appointed by the town of Watertown to consider the matter of sewers for the eastern part of the town, I would respectfully request your consideration of the following: the original plan for sewerage of this portion of the town contemplated a trunk sewer through a part of Arlington Street, across the arsenal grounds and under the Charles River to a connection with the trunk sewer of the Charles River system. This method would necessitate a long trunk sewer at great expense through a district at present very thinly settled, and which would not require a sewer for many years. A much less expensive system, and one which would meet the needs of district more fully, would be an outlet into the north metropolitan system through a connection with the Cambridge sewers at a point about six hundred feet northerly of the Mount Auburn Street bridge over the Watertown branch of

the Fitchburg Railroad, where the sewer in Holworthy Place crosses the tracks of this railroad. The extreme area which could possibly be drained to this connection from Watertown is about four hundred acres. The present actual needs of the district cover a much smaller area, but, with the widening of Mount Auburn Street in conformity with the order of the county commissioners, nearly the whole of the district comprised in the area given above will undoubtedly soon require sewers.

This committee, of which I am a member, desires, if possible, your approval of this method of sewage disposal for this section of Watertown into the north metropolitan system.

Very respectfully yours,

(Signed) Wm. T. Pierce,
For the Watertown Committee on Sewers.

The engineer reporting on February 3, the following was sent: —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, Feb. 3, 1896.

Wm. T. Pierce, Esq., *Watertown Committee on Sewers,*
13 Exchange Street, Boston, Mass.

Dear Sir: — Your communication of Jan. 31, 1896, in relation to sewage disposal for four hundred acres in the easterly part of Watertown (through city of Cambridge sewers) into the north metropolitan system, was considered by the Board at its annual meeting to-day.

The engineer to the Board reports that, on account of excellent railroad connections and the activity of land development, a population of eight thousand to ten thousand may be anticipated in the near future upon the four hundred acres considered. Drainage from this population would be delivered into the westerly end of our Cambridge branch, which is only twenty-seven by twenty-eight inches in diameter, and designed none too liberally for an anticipated population of thirteen thousand from the Lowell Street area of Cambridge in 1930. The addition of drainage from a population of ten thousand people would reduce the life of the Cambridge branch at least ten years.

The Board is not prepared to recommend a project which so seriously cripples the branch. The present actual needs of your district, covering say thirty acres, with an anticipated population of six hundred to seven hundred and fifty people, would not seriously reduce the life of the metropolitan branch. The Board is,

however, of the opinion that chapter 439 of the Acts of 1889 does not give authority to deflect even this small amount of drainage from the Charles River to the north metropolitan system.

For the Board,

(Signed) Edward P. Fisk,
Clerk.

On April 22, 1896, a member of the Watertown sewer committee held a consultation with the Board regarding the aforesaid connection with the north metropolitan system, which resulted in the engineers being directed to make an estimate of cost of a siphon across Charles River for connection with the Charles River system, as originally designed; and on May 23 he presented to the Board his report, estimating the cost of said siphon to be about $9,200.

The engineering department had prepared plans for the siphon, and upon Sept. 5, 1896, the Board signed an application to the Harbor and Land Commissioners of the Commonwealth for the approval of said plans, and authorized the chairman in behalf of the Board to sign a petition to the Honorable Secretary of War at Washington, D. C., asking his approval also; which was done and duly mailed.

At the meeting of the Board on Sept. 12, 1896, the following communication was submitted: —

Boston, Sept. 11, 1896.

Metropolitan Sewerage Commissioners,
1 Mount Vernon Street, Boston, Mass.

Gentlemen: — At a regular meeting of the Watertown sewer committee it was unanimously voted to request the Metropolitan Sewerage Commissioners to take the necessary land through the property of the Butchers' Slaughtering and Melting Association, and also build the siphon sewer under the Charles River from the Brighton shore to the Watertown shore, with suitable masonry structures on either shore.

If you will forward to the committee properly approved vouchers for labor and supplies for this work, they will be paid from our appropriation.

Yours truly,

(Signed) H. H. Sawyer,
Chairman Watertown Sewer Committee.

The engineer was authorized to proceed with the work of constructing the siphon at East Watertown upon receipt of licenses from the authorities in Washington, D. C., and the Harbor and Land Commissioners of the Commonwealth, which have not been received at this date (Oct. 1, 1896).

Expenditures.

The expenditures upon this system, including all payments on account of contracts during the twelve months ending Sept. 30, 1896, but not including expenses of operation (which are particularly stated in Table E of the Appendix), amount to $52,831.53. This, with the amount previously reported, $735,965.78, makes $788,797.31 as the total expenditures to date.

Your attention is called to tables submitted herewith for matters of detail.

NEPONSET RIVER VALLEY SYSTEM.

At the time of the last annual report of this Board notice had been received that the act (chapter 406, Acts of 1895) authorizing the construction of this system had received the approval of the Executive; the plan and report of our chief engineer had been approved and adopted and sent to the State Board of Health for approval, but no report had then been received from said Board. This Board, at its meeting on Feb. 29, 1896, had the following communication submitted to it: —

Office of State Board of Health,
State House, Boston, Feb. 18, 1896.

To the Metropolitan Sewerage Commissioners, Boston, Mass.

Gentlemen: — The State Board of Health has considered your application with reference to a proposed system of sewage disposal for that portion of the city of Boston and the towns of Milton, Hyde Park and Dedham lying within the valley of the Neponset River, and portions of the city of Newton and the town of Brookline lying within the valley of the Charles River. The application

is accompanied by a plan and profiles and a report of your engineer giving details of the proposed scheme approved and adopted by your Board in accordance with a provision of chapter 406 of the Acts of 1895.

The plan provides for a main sewer from a point on Worley Street, near Weld Street, in the West Roxbury district of the city of Boston, through various streets and private lands to the bank of the Charles River, a short distance above the Brookline water works pumping station, thence in the vicinity of the right bank of the Charles River and along the left bank of Mother Brook and the Neponset River to the Dorchester intercepting sewer of the city of Boston at Central Avenue in Dorchester. The capacity of the latter sewer is limited by a section below Baker's Court in Dorchester, which has a capacity of only about twenty cubic feet per second, and it is estimated that the capacity of this sewer, if the sewage of the Neponset valley is discharged into it, will be attained about the year 1905. To provide for the disposal of the sewage after this date two methods are suggested, by either of which the sewage in the Neponset intercepting sewer would be diverted at a point on River Street, Hyde Park, about 500 feet below the Mattapan paper mill, and conveyed by gravity either to the Boston main drainage sewer at Squantum or an independent outlet at Nut Island in Quincy. With this end in view the Neponset intercepting sewer has been designed, with a capacity above the point of diversion estimated to be sufficient for the probable needs of the valley until 1930, while below this point the capacity is proportioned to that of the limiting section of the Dorchester intercepting sewer, estimated to be sufficient until 1905.

In designing the Boston main drainage system it was anticipated that the sewage from the higher portions of the district bounded by the Charles River, Mother Brook and the Neponset River could be at some future time intercepted by a "high-level" sewer and conveyed to Squantum by gravity, thus affording relief to the pumping station and tunnel when the flow of sewage shall tax their capacity, and provision was made in the construction of the works for the connection of such a sewer with the outfall works at Squantum and Moon Island. Your investigations indicate that a feasible route for this sewer can be found, which would intercept the proposed Neponset valley sewer at the point where its size is reduced, on River Street in Hyde Park. Your investigations also indicate that a feasible route for an intercepting sewer from this point to Nut Island may also be found. With regard to disposing of the sewage in the future by either of these methods the Board can express no opinion with the information available at the pres-

ent time, and you have verbally requested that the consideration of these matters be omitted. The Board has accordingly considered only that portion of your application which refers to the disposal of the sewage of the Neponset valley by means of the proposed sewer shown on the plan contained in the seventh annual report of your Board, opposite page 38, which provides for the discharge of the sewage into the Dorchester intercepting sewer at Central Avenue in Dorchester.

With regard to this portion of the scheme, the Board finds that the proposed sewer will provide a satisfactory means of disposal for the sewage of the territory in the Charles and Neponset valleys which it is estimated to serve, probably until about the year 1905, if care is taken in the construction of the main sewer and tributary systems to exclude surface and ground water from the sewers so far as possible, and if the amount of manufacturing sewage is restricted by preventing the discharge into the sewer of water from manufacturing establishments that can be properly discharged into natural water courses.

The size of the proposed sewer above the point where it is expected that the sewage will be diverted at some future time appears to be sufficient to make a reasonable provision for a population as great as may be expected to be connected with this portion of the system in 1930, so far as can be judged by present indications. The size of the sewer below the point where it is expected that the sewage of the Neponset intercepter may be diverted is such as to serve the low districts in Dorchester and Milton for many years after the sewage of the upper portion of the system is diverted.

The Board approves the plan of disposing of the sewage of the Neponset valley by discharging it into the Dorchester intercepting sewer of the city of Boston, but expresses no opinion as to the most appropriate method of disposal to adopt after the capacity of this sewer is reached. The increase in the amount of sewage to be disposed of by the Boston main drainage system will necessitate before long the enlargement of the reservoir capacity at Moon Island, and the necessity for enlargement will be hastened by the addition of the Neponset valley sewage.

It is understood that the sewerage systems to be connected with the Neponset valley sewer shall be constructed upon the so-called "separate" plan, and that no sewage overflows will be used in connection with the main sewer or tributary systems.

By order of the Board,

(Signed) Saml. W. Abbott,
Secretary.

To this the following reply was sent: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, March 18, 1896.

To the Honorable the State Board of Health, State House, Boston, Mass.

GENTLEMEN: — In your reply of Feb. 18, 1896, to our application for approval of plans for sewage disposal for Neponset River valley, at the close you say: "It is understood that the sewerage system to be connected with the Neponset valley sewer shall be constructed upon the so-called 'separate' plan, and that no sewage overflows will be used in connection with the main sewer or tributary systems." As we are informed and understand, you do not by the use of the words "no sewage overflows will be used," etc., intend to prohibit or prevent the construction of such provision for temporary overflows as it would seem necessary should be provided for use in case of accident or necessity of repair of trunk sewer. Unless we hear from you to the contrary, we shall proceed to construct the main trunk sewer and approve local connections therewith, making and requiring such provision for such overflows similar to those provided and required in the Charles River and north metropolitan systems, to be used only in case of emergency.

For the Board,
Very respectfully yours,
(Signed) EDWARD P. FISK,
Clerk.

The reply of the State Board of Health follows: —

OFFICE OF STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, March 26, 1896.

To the Metropolitan Sewerage Commissioners, Boston, Mass.

GENTLEMEN: — The State Board of Health received from you, on March 18, a communication with reference to the use of sewage overflows in connection with the proposed Neponset valley sewerage system, in which you state that unless you hear from the Board to the contrary you shall proceed to construct the main trunk sewer and approve local connections therewith, making and requiring such provisions for such overflows similar to those provided and required in the Charles River valley and north metropolitan systems, to be used only in case of emergency.

The plan presented by you for an intercepting sewer for Nepon-

set River and Mother Brook basins, including a portion of the Charles River basin, which this Board approved in its communication dated Feb. 18, 1896, did not contain any provision for sewage overflows, and no mention of sewage overflows was made in the report of your engineer submitted with the application.

Before the Board can approve a plan providing for sewage overflows it will be necessary that you submit a plan showing the location of the proposed overflows, with a description of the proposed method of constructing and operating them.

By order of the Board,

(Signed) Saml. W. Abbott,
Secretary.

On April 18 the Board authorized the clerk to send the following in reply : —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, April 18, 1896.

The State Board of Health, Boston, Mass.

Gentlemen : — In response to your communication of March 26, 1896, stating that a plan will be required showing the proposed overflows from the Neponset valley intercepting sewer, with a description of method of construction and operation, the Board desires to state as follows : the Charles River system has been operated since 1892 as a branch of the Boston main drainage. During rainy weather, and when the pumps are not in operation, the trunk sewer of the Boston system has been surcharged, flooding the Charles River branch and requiring the construction and maintenance of automatic overflows for the efficient and safe operation of the system. The Board has deemed it expedient to require, for safety and convenience in maintaining and repairing the sewer, and as a further safeguard against flooding from Boston's system, that cities and towns tributary to the Charles River system should also construct and maintain automatic overflows at all their connections from areas of considerable size.

The Neponset valley intercepter, like the Charles River main, will, when completed, be operated as a branch of the Boston system, and it is anticipated that it also will be subject, at its lower end, to flooding during the surcharged condition of the Boston trunk sewer. The Board is of the opinion that the safe operation of the Neponset branch will require the following overflows from the main sewer : —

First. — At Granite bridge, Dorchester, an automatic overflow into the tidal currents of Neponset River, having a carrying capacity equal to the main sewer at that point.

Second. — Near Mill Lane, Dedham, an overflow into Mother Brook, having a carrying capacity equal to the main sewer at that point, controlled by a Penstock valve, to be operated by hand and only when the main sewer is surcharged at that point.

Plans of the proposed overflows are submitted, as requested.

For convenience and safety in maintenance, to provide against possible accident or injury to the main sewer, or flooding at low levels from Boston main sewer, the Board is of the opinion that, as in the Charles River branch, automatic safety overflows should be provided from all local connections receiving drainage from ten acres or more; such overflows above East Street, Dedham, to be permanently sealed off, and never used so long as the Charles River and its shores are used as a source of domestic water supply.

At the date of the engineer's preliminary report on the Neponset valley sewer, the Board had not decided to acquire the Dorchester intercepter from Central Avenue to Granite bridge, and were not prepared and did not at that date ask advice in the matter of overflows from the main sewer. With the exception of Milton, no city or town of the valley above Central Avenue had then prepared any studied scheme for its local connections, and the Board was equally unprepared to ask advice at that date in the matter of overflows from local connections. The engineer to the Board, after conference with the engineers for the tributary cities and towns, has prepared a study for a system of branches for local connections, which are shown on the accompanying map, subject to such minor modifications of size, location, etc., as may necessarily be developed during the more detailed surveys for the construction of local sewers. The Board desires to approve and adopt automatic relief overflows at all the connections shown, with the understanding that such as are above East Street, Dedham, shall not be opened for use so long as the Charles River is used as a source of water supply for Brookline, Newton and other cities. A characteristic study for one of these connections is submitted, and your advice and approval is asked in the matter of overflows from the main sewer and from local connections as outlined above.

Respectfully submitted,

For the Board,

(Signed) EDWARD P. FISK,
Clerk.

To this the following was received: —

OFFICE OF STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, May 7, 1896.

To the Metropolitan Sewerage Commissioners.

GENTLEMEN: — The State Board of Health received from you, on April 18, an application for approval of proposed sewage overflows in connection with the proposed Neponset valley intercepting sewer, accompanied by plans showing the location of proposed overflows from the main sewer and tributary systems and designs for these overflows. Two of these overflows are proposed for the discharge of sewage from the main intercepting sewer, and it is understood that the others are automatic overflows to be connected with the tributary systems near their junction with the main sewer, by which sewage from the tributary sewers may be discharged into local water courses when the sewage in the intercepting sewer rises to a certain height. One of the proposed overflows presented by you is located upon the main sewer at Granite Bridge, but, since this is below the portion of the sewer to which the reply of the Board, dated Feb. 18, 1896, was limited, at your request, the Board has omitted consideration of this overflow.

It is stated in the application that your Board "desires to approve and adopt automatic relief overflows at all connections shown, with the understanding that such as are above East Street, Dedham, shall not be opened for use so long as the Charles River is used as a source of water supply for Brookline, Newton and other cities." As the discharge of sewage into the Charles River in this vicinity is, under present conditions, prohibited by law, this Board cannot approve any overflows upon this portion of the sewer at the present time. The overflows under consideration, therefore, are those included on the main sewer and tributary systems between the point where the sewer crosses East Street in Dedham and its junction with the Dorchester intercepting sewer at Central Avenue, Dorchester.

By the existing conditions, sewage from all overflows in this district would naturally be discharged either into Mother Brook or the Neponset River, or tributaries of these streams. There are several dams along Mother Brook and the Neponset River, forming mill ponds in some cases of considerable size, and all of the proposed overflows would be above one or more of these dams. There is a large and rapidly growing population in the vicinity of these streams and their tributaries, and, in the opinion of the Board, it is desirable that these streams be kept free from pollu-

tion, and that the discharge of sewage into them be prevented, if possible.

Regarding the danger of the proposed main sewer and tributary systems becoming surcharged by sewage by backing up from the Boston system, the Board is informed that by existing provisions the Dorchester intercepting sewer is automatically disconnected from the Boston main drainage sewer at times when the latter is surcharged, and provision is made whereby the Dorchester intercepting sewer may at such times discharge into tide-water; moreover, according to the plan approved by this Board in a communication to your Board, dated Feb. 18, 1896, the bottom of the Neponset valley sewer at its lower end in Central Avenue, Dorchester, is at about grade twenty, or several feet above high water. It does not seem to this Board that there is danger that the Neponset valley sewer may be surcharged from this cause.

Regarding the necessity of automatic overflows for safety and convenience in maintaining and operating a separate system of sewers, much information is furnished by experience in the operation of such systems already in use in this State. A number of such systems have been in successful operation, in some cases for several years, without automatic overflows, and information regarding these systems indicates that the necessity for such overflows has not arisen.

In view of all the circumstances, the Board declines to modify its approval under date of Feb. 18, 1896, of a system of sewage disposal for Neponset River valley which had been submitted by you, by adopting, as a part of that plan, the plan of automatic relief overflows proposed in your communication of April 18, 1896.

It is possible that there are points in the system not known to this Board where unusual emergencies may occur, and where safety would require an outlet gate which can be opened temporarily; if such points are found to exist this Board will consider plans you may present in regard to them, but this Board is desirous to avoid discharging sewage above any of the mill-dams on Neponset River when not absolutely necessary.

By order of the Board,

(Signed) Saml. W. Abbott,
Secretary.

At its meeting on May 2, 1896, this Board passed the following: —

Voted, That, for the purpose of constructing, maintaining and operating the Neponset valley system of sewerage, it is neces-

sary to take Sections 9, 10 and 11 of the Dorchester intercepting sewer, extending from Granite Avenue, along the Neponset River to Central Avenue, in Dorchester, and that plans of said sections are approved and adopted, and that a communication to the State Board of Health be made transmitting said plans for their approval; and that said communication be signed by the chairman.

In accordance with the above the following was sent: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 1 MT. VERNON STREET,
BOSTON, May 2, 1896.

To the State Board of Health, Boston, Mass.

GENTLEMEN: — This Board has this day determined that for the purpose of constructing, maintaining and operating a system of sewage disposal for the city of Boston and the towns of Dedham, Hyde Park and Milton, under the provisions of chapter 406 of the Acts of the year 1895, it is necessary to take that part of the Dorchester intercepting sewer of the Boston main drainage system which extends from Granite Avenue in Dorchester, alongside of the Neponset River to Central Avenue in Dorchester, as indicated on three plans herewith submitted of even date, marked Metropolitan Sewerage Commission, Neponset valley system, Sections 9, 10 and 11, and has this day approved and adopted said plans as a part of said system of sewage disposal supplementary to the plans already approved and adopted by this Board and approved by you.

We therefore transmit this report and these plans to you for your approval.

Very respectfully yours,
(Signed) HOSEA KINGMAN,
Chairman.

To the above the following reply was received: —

OFFICE OF STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, June 6, 1896.

To the Metropolitan Sewerage Commissioners.

GENTLEMEN: — The State Board of Health has considered the application submitted by you on May 4, 1896, in which you request the approval by this Board of the taking by the Metropolitan Sewerage Commissioners of the portion of the Dorchester intercepting sewer between Central Avenue and Granite Avenue, in Dorchester, as a portion of the proposed Neponset valley sewerage

system, provided for by chapter 406 of the Acts of the year 1895, and having carefully considered the plans, hereby approves them as a part of the system of sewage disposal for the Neponset valley, supplementary to the plans already approved by this Board.

By order of the Board,

(Signed) Saml. W. Abbott,
Secretary.

Contracts.

At its meeting on Oct. 4, 1895, the Board directed the engineer to prepare contract plans for this system, and on Feb. 29, 1896, directed that Sections 13, 14, 15 and 16 be advertised, bids upon the two former to be received until noon of Saturday, March 21, and those of the two latter until noon of Saturday, March 28, 1896. The bids on these sections were accordingly received and opened as advertised, and Table B in the Appendix contains a full list of the bids on each section, together with a statement in each case of the one accepted. The methods formerly adopted and used for receiving and opening bids have been fully described in previous reports, and were followed in each instance in this case, the contract being awarded on each of these sections, and on nearly every section of this system, to the lowest bidder. Harry P. Nawn was awarded, and duly executed, the contracts, furnishing sureties on the bonds, as required by the Board. The Board at its meeting on March 28, 1896, directed that Sections 17, 18, 19 and 20 be advertised, bids upon the two former to be received until noon of April 18, those upon the two latter until noon of April 25, 1896. These sections were accordingly advertised as directed, and on April 25 the Board accepted the bid of Geo. R. Newman & Co. of Providence, R. I., the lowest bidder on Section 17, for the construction of said section, and at the request of Wm. T. Ross of Waltham, the lowest bidder on Section 18, granted permission for the withdrawal of his bid, and accepted the bid o the Troy Public Works Company of Troy, New York, the next lowest bidder, for constructing said section. The successful bidders on these sections furnished bonds and sureties acceptable to the Board. The Board on the same date (April 25) received bids for constructing Sections 19 and 20, which on May 2,

1896, were in each case awarded to Geo. S. Good & Co. of Lock Haven, Pa., the lowest bidders, who duly executed contracts and furnished bonds for the same on both sections. At its meeting on May 16, 1896, the Board voted that the sections (21 to 25 inclusive) be advertised, bids for the first two (21 and 22) to be opened June 13 and the remainder (23 to 25) June 20, 1896. On June 13 bids were received on Sections 21 and 22, and upon June 27 the Board accepted the bid of Ezra A. Mathers of Washington, D. C., for constructing said sections, he duly executing contracts and furnishing sureties acceptable to the Board. The Board at this date (June 27) received bids for three sections (23, 24 and 25) of this system, postponing action thereon until certain facts regarding some of the bidders could be ascertained. At its meeting on July 1, 1896, the bid of Haskins & Murphy, the lowest bidders on Section 23, was accepted, as was also their bid upon Section 24; while on Section 25 the Board accepted the bid of Edw. W. Everson, all of said parties duly executing their contracts and giving bonds acceptable to the Board. Your attention is called to tables B and C of the Appendix, where a statement may be found of all bids received, together with the date of said reception and the award made in each case.

Land Takings.

The land takings of the Board during the past year have all been upon this system. On March 28, 1896, the Board executed deeds, taking the right to construct, operate and maintain an underground sewer, partly in Boston and partly in Hyde Park, covering Sections 13, 14, 15, 16 and 17 in part, which deeds and plans have been recorded; that in Boston in Suffolk Registry, book 2347, page 385; that in Hyde Park in Norfolk Registry, book 757, page 214. These takings comprise the right of way necessary for the construction of the sewer from the point in Central Avenue in Dorchester, where the three sections constructed by the city of Boston, previously referred to, terminate, to and including River Street in Hyde Park, in the vicinity of the Mattapan Mills.

On April 25, 1896, the Board executed a deed (recorded in Norfolk Registry, book 759, page 601) taking "rights, privileges and easements" in land in Hyde Park, as shown on two plans. This taking includes the line of the sewer from the point in River Street (east) where the preceding taking terminated to a point in River Street (west) in the vicinity of Atherton Street.

On June 13, 1896, the Board executed a deed (recorded in Norfolk Registry, book 764, page 5) taking the right of way in Hyde Park and a part of Dedham, comprising the territory on the line of the sewer, from the terminus of the former taking in River Street in the neighborhood of Atherton Street to the property of the Merchants' Woollen Company at Emmett Avenue and Colburn Street in Dedham.

The only other taking on this line made during the year is dated July 1, 1896, and recorded with Norfolk Deeds, book 764, page 501. This taking includes the right to construct, operate and maintain the sewer in land from the terminus last mentioned to a point in the line dividing land of J. H. Nay from land of Elijah Bonnemort, about three hundred and fifty feet beyond the point where the sewer crosses the Dedham branch of the New York, New Haven & Hartford Railroad.

Location of Sewer Line.

The centre line of the sewer on these sections may be described as follows: beginning at a point on Central Avenue in Dorchester, where the sections constructed by the city of Boston terminate, the line passes through said avenue and is deflected to the west, through land of the Tileston & Hollingsworth Company, and crosses under the mill pond of said company to the vicinity of the ice house; from here it crosses various private estates, on the line of a proposed street, to River Street, and follows the line of said street to Fremont Street. Opposite said Fremont Street it passes through various private estates along the line of the river and the New York, New Haven & Hartford Railroad to Mattapan Square, which it crosses, and continues along River Street, crossing the boundary line between Boston and

Hyde Park and continuing in said River Street to a proposed street leading to the river, on land now or late of the Sally R. Sumner estate. Following this proposed street to the river and deflecting to the south-west, it follows the bank of the river through various private estates to West Street, which it crosses, and continues through private estates and land of the New England Railroad Company to Station Street in the neighborhood of Hyde Park station, through which street it passes and crosses the railroad from said street to Walnut Street; passing through said Walnut Street and Walnut Place to land of Blaikie's Woollen Mill, which land it crosses to Hyde Park Avenue, and is continued in said avenue and Factory Street to the Providence division of the New York, New Haven & Hartford Railroad. Here the railroad is crossed to Barry Place, and the sewer is continued in said place to Business Street, which street is followed to River Street. The sewer is continued in said River Street to the south-westerly line of Atherton Street, where it passes through private estates along Mother Brook (crossing the boundary line between Hyde Park and Dedham) to the junction of Mill and Lewis lanes with Emmett Avenue. Crossing said Mill Lane, it continues through private estates to Colburn Street, which street it follows to Maverick Street, and continues in said Maverick Street for about two hundred feet, where it deflects to the north-west and follows through private land, along Mother Brook to Curve Street, in which it continues across East Street; and after following East Street for about one hundred and fifty feet, deflects to the north-west, crossing private estates, to the end of the section, about three hundred and fifty feet beyond the crossing of the Dedham branch of the New York, New Haven & Hartford Railroad.

The total length of this line is 35,656 feet, of which 20,241 feet lie in private land and 15,415 feet in public highways.

There have been no settlements for land taken upon this system. The Board has caused, however, three disinterested parties to view the estates affected by said takings, and they have reported in writing to the Board the damage sustained in each particular case, which report is on file in this office.

Some of the parties owning the estates thus affected have agreed to accept the award so made, and later the amount agreed upon will be paid them upon their giving the Commonwealth satisfactory releases.

On July 21, 1896, S. B. Balkam & Co., for good and sufficient consideration, signed an agreement to execute a release on or before July 1, 1897, for land embraced within a taking made March 28, 1896, providing certain things in said agreement were performed by this Board meantime.

Expenditures.

The expenditures upon this system for the year have been $200,604.35. This, with the amount previously reported, $2,649.95, makes $203,254.30 expended to date, particulars of which will be found in the Appendix.

In the letter of the chairman of this Board, under date of Jan. 28, 1896, to the committee on metropolitan affairs (already quoted), attention is called to the fact that by chapter 406, Acts of 1895, but $500,000 is appropriated, while the studies and plans indicate that considerably more will be required for the completion of the work authorized. After speaking of this, he says: "We call attention to this, not that we think it will be necessary to make any additional appropriation for this purpose this year, as the present appropriation will probably be sufficient for all the work we can accomplish in this direction this year, but that you may have a full understanding of the situation."

Accordingly, this Board would recommend, and ask, that an additional sum of $300,000 be provided for the completion of this system.

GENERAL — ALL SYSTEMS.

Commission to apportion Costs and Expenses.

In the last annual report, after stating that on Feb. 5, 1895, the court appointed William C. Endicott of Salem, with John E. Sanford and Edmund H. Bennett, both of Taunton, commissioners, under section 14 of chapter 439 of the Acts of 1889, we say: —

Here the matter has rested to this time (Oct. 1, 1895); but the Hon. Wm. C. Endicott, one of the commissioners appointed, having declined said appointment, the court will be asked at an early date to appoint a successor.

The supreme judicial court of Suffolk County, sitting in equity in answer to a petition filed in said court Oct. 4, 1895, did on October 9 of said year appoint Everett C. Bumpus of Quincy, county of Norfolk, to be commissioner in place of William C. Endicott of Salem, declined; and in answer to a petition of this Board, filed in said court Oct. 14, 1895, praying for the appointment of three commissioners to apportion the expenses upon the Neponset River valley system, under chapter 406, Acts of 1895, issued a decree on December 16 of the same year appointing the same three commissioners, viz., Edmund H. Bennett and John E. Sanford of Taunton and Everett C. Bumpus of Quincy, for said purpose.

Said commission has not at this date made its report; but we are permitted to print the following from advanced sheets, furnished us by said commission, substantially in the same form that will be presented to the court later, which is self-explanatory: —

COMMONWEALTH OF MASSACHUSETTS.

Supreme Judicial Court. Suffolk, ss. In Equity, No. 4728.

Hosea Kingman and others, Metropolitan Sewerage Commissioners, Petitioners. *In re* The North Metropolitan and the Charles River Sewerage Systems. St. 1889, c. 439; St. 1894, c. 307; St. 1895, c. 294; St. 1896, c. 414.

Suffolk, ss. In Equity, No. 5056.

The Same, Petitioners. *In re* The Neponset River Sewerage System. St. 1895, c. 406.

REPORT AND AWARD.

These are petitions for the appointment of apportionment commissioners under the several special laws of this Commonwealth, known as the metropolitan sewerage acts.

North Metropolitan and Charles River Systems.

The original act, St. 1889, c. 439, authorized the construction, maintenance and operation by the Commonwealth of two systems

of public sewers, extending through the Mystic River valley and the Charles River valley to tide-water. The construction of these systems has been practically completed; so that now, as stated in the last annual report of the Metropolitan Sewerage Commissioners, both systems "are in operation and receiving sewage from the cities and towns for whose relief they were built."

The Mystic River main sewer commences in the town of Stoneham, runs by a circuitous course, with various lateral branches, in a general south-easterly direction, and discharges into the sea at Deer Island. This system, known as the north metropolitan system, originally embraced the following cities and towns, as alphabetically arranged: Arlington, Belmont, Boston (East Boston and Charlestown districts), Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville, Stoneham, Winchester, Winthrop and Woburn. To these was added, by St. 1896, c. 414, a small area at the southerly extremity of the town of Wakefield, comprising the villages of Greenwood and Boyntonville.

The Charles River sewer begins at the lower line of Waltham, extends along the southerly bank of Charles River to the intersection of Gainsborough (formerly Camden) Street with Huntington Avenue, in the city of Boston, and thence discharges through the Boston main sewer into tide-water at Moon Island. This system includes the main area of the city of Boston, with Brookline, Newton, Waltham and Watertown. It has no physical connection with the north metropolitan system.

To provide for the cost of constructing these two systems, the original act authorized an issue by the Commonwealth of its scrip or certificates of debt, to be designated on the face thereof as the metropolitan sewerage loan, for a term not exceeding forty years, and to an amount not to exceed $5,000,000. By supplementary acts, additional issues have been authorized as follows: by St. 1894, c. 307, $500,000; by St. 1895, c. 294, $300,000; and by St. 1896, c. 414, $30,000, — making a total authorized loan of $5,830,000 for the two systems.

Although these additional issues were intended exclusively for the completion or enlargement of the north metropolitan system, each of the supplementary acts expressly provides that "Any scrip or certificates of debt issued under the provisions of this act shall be considered as an addition to, and shall become a part of, the loan authorized by [the original act] chapter 439 of the Acts of the year 1889;" and that "the sinking fund established under the provisions of said chapter shall be a sinking fund for the extinguishment of the debt authorized by this act;" with an added provision for a corresponding enlargement of the sinking fund.

While, however, but one loan and one sinking fund have been thus provided for the construction of both of these systems, the cost of the construction of each system, as well as the current expense of its maintenance and operation, is carefully discriminated in the accounts kept by the proper officers of the Commonwealth; so that, as hereinafter shown, an apportionment can (and should) be so made that the cities and towns in the respective systems shall pay only such portion of the total cost of both systems as is strictly chargeable to the particular system to which they belong.

The total authorized loan of $5,830,000, issued (or to be issued) as above, bears interest at the rate of three per cent. per annum, and matures Jan. 1, 1930.

Neponset River System.

By St. 1895, c. 406, a third system was established to dispose of the sewage of the Neponset River valley. The main sewer of this system, now under construction, will begin at Worley Street in the West Roxbury district of the city of Boston, and, with provision for branches to Brookline and Newton, will run in a southerly and easterly course, along the northerly side of Mother Brook and Neponset River, to Central Avenue at Dorchester Lower Mills. It here connects with the end of the Dorchester intercepting sewer and discharges through that sewer, and thence through the main sewer of the city of Boston, like the Charles River system, into tide-water at Moon Island. The territory tributary to this system includes considerable areas in the West Roxbury and Dorchester districts of Boston, with the towns of Dedham, Hyde Park and Milton.

For the construction of this system the act provides for a State loan of $500,000, on terms and conditions precisely similar to those in the case of the loan for the north metropolitan and Charles River systems. The two loans, however, although designated in the respective acts by the same title, are wholly distinct loans, as are also the sinking funds provided for their redemption; and all accounts pertaining to the two will be so kept. The apportionment of cost and expense for the Neponset River system is therefore to be made in entire independence of that for both or either of the other two systems.

The loan for the Neponset River system also bears interest at the rate of three per cent. per annum, but will mature March 1, 1935.

Apportionment of Cost of Construction, Maintenance and Operation.

All of the sewerage acts provide in the same terms that the expenditure incurred by the Commonwealth in the construction of the several systems shall be repaid by the cities and towns included therein, in annual payments sufficient to meet the accruing interest on the respective sewerage loans, and sufficient also to create sinking funds which, with their accumulations, will extinguish the loans at their maturity. The cities and towns in each system are required in like manner to reimburse to the Commonwealth the annual cost of maintenance and operation.

The several acts further provide for the appointment by the supreme judicial court of three commissioners, whose duty it shall be *to determine the proportions* in which the several cities and towns in each system shall annually, for the term of five years next following the year of the first issue of sewerage scrip or certificates of debt as aforesaid, pay money into the treasury of the Commonwealth; *first*, to meet the *interest and sinking fund requirements* for each of said years, as estimated by the treasurer; and *second*, to meet the *cost of maintenance and operation* for each of said years, as estimated by the Board of Metropolitan Sewerage Commissioners and certified to the treasurer. Commissioners are to be appointed in like manner to make a similar apportionment for each succeeding term of five years.

In May, 1891, Ebenezer R. Hoar, William C. Endicott and John E. Sanford were accordingly appointed the commissioners to make such apportionment for the north metropolitan and Charles River systems for the first term of five years, 1891 to 1895, both inclusive; and their award, made in November, 1891, was duly accepted by the court, and has been fully complied with by the several cities and towns in those systems.

On Oct. 9, 1895, the undersigned, Edmund H. Bennett, John E. Sanford and Everett C. Bumpus, by an order of the supreme judicial court, under the first of the above petitions, were appointed the commissioners to make such apportionment for the north metropolitan and Charles River systems for the *second* term of five years; and on Dec. 16, 1895, by a like order under the second petition, they were appointed to make such apportionment for the Neponset River system for the *first* term of five years; the term in both cases covering the same period of years, namely, 1896 to 1900, both inclusive.

Although, as before stated, the financial relations of the three systems to the Commonwealth and to each other are such that they

must, for the purposes of the apportionment, be treated as distinct systems, they are nevertheless essentially alike in their legal constitution and character, and in the scope and purpose of their creation. We have therefore seen no reason why the same general principles and rules or methods of apportionment should not apply to the several systems alike, or why, as regards our present duty, they should not all be dealt with in one and the same report.

After receiving notice of our appointments as above, we accordingly assigned a time and place for hearing all of the parties interested in the matters submitted to our determination, and gave due notice thereof to the cities and towns named in the several sewerage acts, as well as to the Board of Metropolitan Sewerage Commissioners; and all of said cities and towns appeared by their proper officers, solicitors or counsel, at the time and place appointed for such hearing, or at the adjournments thereof, with such witnesses, evidence and arguments as they saw fit to produce or offer; and they have been publicly heard by all of us sitting together as fully as they or any of them desired. Said hearings were held, with the acquiescence of all parties, either at the State House, or at the Court House in Pemberton Square, Boston, on Feb. 8, March 6 and 20, April 24, May 1, 8 and 22, and June 3, 26 and 27, 1896. The Metropolitan Sewerage Commissioners and their engineer and clerk have also appeared before us or met with us from time to time, and have given such information as was requested of them, both at the public hearings and at our meetings for conference and for the further investigation of the facts involved in our decision.

Basis of Apportionment.

The question that first presents itself, and the question of radical importance in the case, is *the basis* on which the apportionment should be made. The several acts prescribe no definite standard or rule. They all provide, in the same broad terms, that the commissioners appointed for the purpose shall make the apportionment "*in such a manner as they shall deem just and equitable;*" and this is the definition of our duty as laid down by the court in the orders of our appointment.

It should, perhaps, be noted that the act creating the Neponset River system (St. 1895, c. 406, § 16) contains this additional clause: "In making their award, the commissioners may take into consideration the amount of the use of the sewers by said city or towns respectively; the population and valuation thereof; and also the extent, if any, to which said main sewers relieve the city or towns respectively of the necessity of constructing local sewers at

their own charge; and any other considerations as may seem to them just and equitable." We construe this language, however, as permissive or suggestive, rather than as directory; and we do not understand that it adds anything to the powers or duties implied in the more brief and comprehensive formula first above quoted.

At the hearings before us, various bases or methods of apportionment were urged or suggested, in behalf of a few of the municipalities concerned, as desirable or possible to be adopted, or as at least proper to be taken into equitable consideration; such, for example, as an apportionment of the whole cost of construction and expense of maintenance and operation according to the assessed value of real and personal estate, or according to the assessed value of real estate alone, without regard in either case to population; or according to population alone, without any regard to taxable valuation; or according to the total areas, the assessed areas, the drainable areas, or the areas actually sewered, in the several cities and towns; or by taking into account the length of public sewer lying within the city or town limits, and the number of connections, present and prospective, of the local sewers therewith; or the location of the public sewer, as running through the middle or on the outskirts of the city or town, and the consequent expense of extending the local sewers to connect with it; or the amount of storm or surface water admitted into the local sewers and thereby discharged into and through the public sewer; or the nature of the subsoil, and the amount of underground percolation, direct and indirect, into the public sewer; or the fact that the city or town had already established an efficient sewerage system of its own; or the probable rapidity of municipal growth in population and wealth during the period to be covered by the apportionment.

This enumeration might be extended; but it is already long enough to indicate how difficult a problem it might be to combine, in their just proportions, elements and factors so complex and diverse, and of such unknown or conjectural value, so as to arrive at a formulated and intelligible result. However diligently and conscientiously we might labor to work out such an apportionment, we apprehend that we should not in the end be able to assure ourselves beyond a reasonable doubt that it was "just and equitable," and much less to convince the great majority of those concerned that it was not fanciful and arbitrary.

Valuation and Population.

So far as may be consistent with substantial justice, it is desirable that the bases and methods adopted should be simple, definite, easily understood and of familiar application. Under our laws, no facts are more carefully ascertained than the taxable value of real and personal property, and the resident population, in the several cities and towns. When ascertained, these facts become matters of public record, about which there can be no dispute; and they are the usual and approved factors in the adjustment of public rights and the apportionment of public burdens.

The sewerage systems in question were established "to promote the public health, to avert disease and to prevent nuisances." (153 Mass. 571.) We have been unable to find, upon the whole, any better measure of the ability and duty to contribute to the cost of public works of this character than the taxable valuation of the several cities and towns which compose the districts for whose common welfare these systems were created, or any better measure of the use enjoyed and the benefits received by the several municipalities than the number of persons who dwell within their respective limits.

We have accordingly determined to apportion the payments required to meet the *interest and sinking fund requirements* of the sewerage loans, which represent the *cost of construction*, upon the basis of *valuation;* and the payments required to meet the annual *cost of maintenance and operation*, upon the basis of *population*. For the former purpose we have used the property valuations which are established by St. 1895, c. 90, as the basis for the apportionment to cities and towns of State and county taxes; and for the latter purpose, the State census of 1895.

We have found in a few of the municipalities areas of larger or smaller extent which lie in other watersheds, and which it is physically impracticable to drain into the systems in question. Proper deductions have been made for the valuation and population of such areas. Portions of the city of Boston are tributary to each of the three systems. The valuation and population of the area tributary to each system are included in the apportionments for that system alone. In the case of the town of Wakefield, the valuation and population of only that section which was annexed to the north metropolitan district by St. 1896, c. 414, have been taken into account, due consideration being given also to the fact that this section had contributed nothing to the cost of construction during the first term of five years.

Apportionment for the North Metropolitan and Charles River Systems.

1. Interest and Sinking Fund Requirements. — As has been stated on page lxiii, there is but one loan provided for the construction of these two systems. This loan represents the cost of both systems. It is clear that each system should contribute to the interest and sinking fund requirements of this loan in proportion to its own particular cost. It is necessary, therefore, to ascertain, as the first step, the actual and relative cost of each system as a whole.

The cost of the north metropolitan system, up to March 1, 1896, was $4,876,831.24. Considerable work remains to be done in the finishing of this system, and there are numerous unsettled contracts and claims, including suits for land damages. This system is also to be extended to Wakefield. Altogether, it is estimated that its total cost will be (approximately) $5,030,000.

The cost of the Charles River system, up to the same date, was $787,895.26. It is estimated that outstanding claims, comparatively few and small, will bring its total cost up to (in round numbers) $800,000.

The total cost of both systems ($5,030,000 + $800,000) will therefore be $5,830,000, which is the exact amount of the loan. Now, $5,030,000 is 86.28 per cent. and $800,000 is 13.72 per cent. of $5,830,000. It follows that 86.28 per cent. of the total cost of both systems is chargeable to the north metropolitan system and 13.72 per cent. to the Charles River system. It is equally clear that 86.28 per cent. of the interest and sinking fund requirements of the total loan should be apportioned to the cities and towns in the north metropolitan system, and that 13.72 per cent. should be apportioned to those in the Charles River system.

Having thus fixed the proportions of the two systems as a whole, it is next necessary to determine, upon the basis of valuation as hereinbefore explained, the proportions of the several cities and towns in each system. The arithmetical process requires no elucidation. Having obtained the latter proportions, it will be evident that the cities and towns in the north metropolitan system should pay their respective proportions or percentages (as thus obtained) of the 86.28 per cent. which has been found chargeable to that system; and that the cities and towns in the Charles River system should pay their respective proportions or percentages (as thus obtained) of the 13.72 per cent. found chargeable to the latter system. By reducing or combining the percentage of each city or town with that of the system to which it belongs, we obtain the

desired proportions or percentages in which the several cities and towns in both systems should contribute to the interest and sinking fund requirements of the whole loan. The results are tabulated below.

We therefore *determine and award* that the several cities and towns in the north metropolitan and Charles River systems shall annually pay money into the treasury of the Commonwealth, for the term of five years, 1896 to 1900, both inclusive, to meet the interest and sinking fund requirements for each of said years, as estimated by said treasurer, of the metropolitan sewerage loan, authorized and issued for the construction of said systems, and any deficiency in the amount previously paid in, as found by said treasurer, in the proportions shown in the right-hand column of the following table: —

Table showing the Proportions in which the Several Cities and Towns in the North Metropolitan and Charles River Systems shall pay Money to meet Interest and Sinking Fund Requirements under Sts. 1889, c. 439; 1894, c. 307; 1895, c. 294; and 1896, c. 414.

CITY OR TOWN.	System.	Percentages.	Proportions.
			Per Cent.
Arlington,	North metropolitan,	2.74 of 86.28	2.36
Belmont,	North metropolitan,	1.30 of 86.28	1.12
Boston,*	North metropolitan,	18.96 of 86.28	20.08
Boston,†	Charles River,	27.08 of 13.72	
Brookline,	Charles River,	33.13 of 13.72	4.55
Cambridge,	North metropolitan,	26.19 of 86.28	22.60
Chelsea,	North metropolitan,	7.37 of 86.28	6.36
Everett,	North metropolitan,	4.01 of 86.28	3.46
Malden,	North metropolitan,	8.19 of 86.28	7.07
Medford,	North metropolitan,	5.29 of 86.28	4.56
Melrose,	North metropolitan,	3.22 of 86.28	2.78
Newton,	Charles River,	25.32 of 13.72	3.47
Somerville,	North metropolitan,	14.33 of 86.28	12.36
Stoneham,	North metropolitan,	1.28 of 86.28	1.10
Wakefield,‡	North metropolitan,	.28 of 86.28	.24
Waltham,	Charles River,	10.02 of 13.72	1.37
Watertown,	Charles River,	4.45 of 13.72	.61
Winchester,	North metropolitan,	2.20 of 86.28	1.90
Winthrop,	North metropolitan,	1.49 of 86.28	1.29
Woburn,	North metropolitan,	3.15 of 86.28	2.72
Total,			100.00

* East Boston and Charlestown districts.

† Brighton and portions of Back Bay and Roxbury districts.

‡ Villages of Greenwood and Boyntonville.

2. *Cost of Maintenance and Operation.* — Separate accounts are kept, as before stated, of the current annual expense incurred by the Commonwealth in maintaining and operating the north metropolitan and Charles River systems, respectively; and there is consequently no occasion for the apportionment of this expense as between the two systems.

The proportions in which the cities and towns in each system shall annually pay money to meet the cost of the maintenance and operation of their own system have been computed upon the basis of population, in accordance with the principles and methods hereinbefore indicated, and with the results shown below.

We *determine and award* that the several cities and towns in the north metropolitan and Charles River systems, respectively, shall annually pay money into the treasury of the Commonwealth, for the term of five years, 1896 to 1900, both inclusive, to meet the cost of the maintenance and operation of said systems for each of said years, as estimated by the Board of Metropolitan Sewerage Commissioners and certified to said treasurer, and any deficiency in the amount previously paid in, as found by said treasurer, in the proportions set down in the following table: —

Table showing the Proportions in which the Cities and Towns in the North Metropolitan and Charles River Systems shall pay Money to meet the Cost of Maintenance and Operation of said Systems, respectively, under Sts. 1889, c. 439; 1894, c. 307; 1895, c. 294; and 1896, c. 414.

NORTH METROPOLITAN SYSTEM.		CHARLES RIVER SYSTEM.	
City or Town.	Proportions.	City or Town.	Proportions.
	Per Cent.		Per Cent.
Arlington,	1.79	Boston,*	26.41
Belmont,	.78	Brookline,	16.24
Boston,†	22.82	Newton,	28.00
Cambridge,	22.47	Waltham,	21.38
Chelsea,	8.61	Watertown,	7.97
Everett,	5.11		
Malden,	8.18		
Medford,	3.98		
Melrose,	3.24		
Somerville,	14.37		
Stoneham,	1.73		
Wakefield,‡	.18		
Winchester,	1.69		
Winthrop,	1.15		
Woburn,	3.90		
Total,	100.00	Total,	100.00

* Brighton and portions of Back Bay and Roxbury districts.

† East Boston and Charlestown districts.

‡ Villages of Greenwood and Boyntonville.

Apportionment for the Neponset River System.

This system, though physically related to the Charles River system so far as to have a similar outlet of discharge through the improved sewerage system of the city of Boston, stands alone as regards the provision made for its construction, maintenance and operation.

It is sufficient to say that the apportionment for *interest and sinking fund requirements* has been made on the basis of *valuation*, and that for *cost of maintenance and operation* on the basis of *population*, in accordance with the same general rules and methods as have been applied to the other systems.

We *determine and award* that the several cities and towns in the Neponset River system shall annually pay money into the treasury of the Commonwealth, for the term of five years, 1896 to 1900, both inclusive, to meet the interest and sinking fund requirements for each of said years, as estimated by said treasurer, of the loan authorized and issued for the construction of said system, and also to meet the cost of the operation and maintenance of said system for each of said years, as estimated by the Board of Metropolitan Sewerage Commissioners and certified to said treasurer, and any deficiency in the amount previously paid in, as found by said treasurer, in the proportions set down in the following table: —

Table showing the Proportions in which the Several Cities and Towns in the Neponset River System shall pay Money to meet Interest and Sinking Fund Requirements, and to meet Cost of Maintenance and Operation, respectively, under St. 1895, c. 406.

City or Town.	Proportions to meet	
	Interest and Sinking Fund Requirements.	Cost of Maintenance and Operation.
	Per Cent.	Per Cent.
Boston,*	23.28	28.14
Dedham,	13.52	19.85
Hyde Park,	18.13	35.51
Milton,	45.07	16.50
Totals,	100.00	100.00

* Portions of West Roxbury and Dorchester districts.

Special Facts and Conditions.

1. Charles River System. — It has been assumed, in making the foregoing apportionments, that the city of Boston would continue, under some contract or arrangement with the Commonwealth, to receive at Gainsborough Street the sewage collected by the Charles River main sewer, and to convey and discharge the same, through its own main sewer, to and at Moon Island. If, as authorized by the original act (St. 1889, c. 439), the latter sewer should be purchased or taken by the Commonwealth and incorporated with the Charles River system, the foregoing apportionments, both for the Charles River system and for the north metropolitan system, would undoubtedly need to be recast and adjusted to the new and materially changed facts and financial conditions which would then exist.

2. Neponset River System. — Authority is given in the act establishing this system (St. 1895, c. 406) for the taking by purchase or otherwise of that portion of the Dorchester intercepting sewer which lies between its Central Avenue terminus and Granite bridge. We are advised by the Board of Metropolitan Sewerage Commissioners that it has been decided to exercise this power at once, or as soon as a more adequate provision shall have been made for the entire cost of this system. We have framed the apportionment on the assumption that this course will be pursued. If for any unforeseen cause the plan should fail to be carried out, a revision of the apportionment for this system also would be necessary.

Edmund H. Bennett,
John E. Sanford,
Everett C. Bumpus,
Apportionment Commissioners.

Upon March 4, 1886, the Board authorized the chairman to sign the following communication in behalf of the Board: —

Commonwealth of Massachusetts,
Metropolitan Sewerage Commissioners, 110 Boylston Street,
Boston, March 4, 1896.

To His Excellency the Governor and the Honorable Council.

Respectfully represents the Board of Metropolitan Sewerage Commissioners, created by chapter 439, Acts of 1889: that it organized in September of that year, and located its offices in the Ames building on Lincoln Street in Boston, which offices were leased for a period of three years from Oct. 1, 1889, with the priv-

ilege of extending the same for six months at the expiration of said time. That on March 10, 1893, said building, with others in that neighborhood, was totally destroyed by fire; and under the circumstances this Board, understanding that certain rooms in the extension of the State House (the same being the room now used for the council chamber, with the small ante-room on each side) had been assigned to them, applied to have them made available for use at the earliest possible moment practicable. This they were given to understand could be effected by September 1 of that year, and they accordingly engaged rooms in the Walker building, at 110 Boylston Street, for one year from March 15, 1893, at a rental of $3,050, with a proviso that said lease might be terminated on August 31, or upon the last day of any month subsequent by giving thirty days' notice in writing. On September 1 the rooms in the State House extension that we had expected to occupy were unfinished, and we were compelled to remain in the Walker building, where the lease has been twice renewed, and will expire on the fourteenth instant.

The total floor area in the quarters assigned the Board in the extension of the State House is approximately three thousand square feet, and includes two large and commodious vaults. The rooms in the Walker building now occupied cover a total area of about twenty-eight hundred square feet, in which have been placed portable safes containing about forty cubic feet. We estimate that about two thousand square feet of floor space on the same or adjacent stories, with about three hundred cubic feet of vault room accessible thereto, would be necessary for our use.

Wherefore this Board prays your honorable body that suitable quarters may be assigned to it in the extension of the State House or other buildings of the Commonwealth.

Very respectfully yours,

(Signed) Hosea Kingman,
Chairman.

This petition was referred to the committee on State House of the council, who, after hearing this Board, made the following report, of which we were duly notified by the following communication: —

Commonwealth of Massachusetts,
Council Chamber, Boston, March 26, 1896.

The committee on State House, to whom was referred the communication from the Metropolitan Sewerage Commissioners asking that suitable quarters be assigned to them in some of the buildings

of the Commonwealth, after a conference with the State House Construction Commissioners and Sergeant-at-Arms, recommend the adoption of the following orders.

CHARLES E. STEVENS,
For the Committee.

Ordered, That the first, second and third stories of the building No. 1 Mt. Vernon Street be assigned for the temporary use of the Metropolitan Sewerage Commissioners, their engineer, secretary, officers, clerks and other employees.

Adopted in council March 26, 1896.

EDWARD F. HAMLIN,
Executive Clerk.

Ordered, That the Metropolitan Sewerage Commissioners be authorized to fit up and occupy the first three floors of building No. 1 Mt. Vernon Street, the cost of repairs to be paid from their contingent fund.

Adopted in council March 26, 1896.

EDWARD F. HAMLIN,
Executive Clerk.

A true copy. Attest:

(Signed) E. F. HAMLIN,
Executive Clerk.

Upon receipt of the above, this Board notified Joseph Walker, the trustee of the property at 110 Boylston Street, which we then occupied, as follows: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 110 BOYLSTON STREET,
BOSTON, April 1, 1896.

JOSEPH WALKER, *Trustee, 53 State Street, Boston, Mass.*

DEAR SIR: — I have sent your agents, Messrs. Whitcomb, Wead & Co., a check for the rent of rooms in the Walker building, 110 Boylston Street, in full to date, with a note that this Board would vacate said rooms on the thirtieth instant, and wish now to say to you that our reason for so doing is to save our rent.

Quarters have been assigned to us in a building owned by the Commonwealth and we shall remove there during the present month, so that the rooms we have been occupying will be at your disposal on May 1, 1896.

For the Board,

(Signed) EDWARD P. FISK,
Clerk.

Quarters having been assigned to us in the building 1 Mt. Vernon Street, preparations were made to put it in suitable order for occupancy, the expense therefor amounting to about $1,600; and preparations were made to have all the effects removed to the new office prior to the first of May, 1896, which was accomplished.

On May 9, 1896, the following petition was sent to His Honor the Lieutenant-Governor and Council: —

COMMONWEALTH OF MASSACHUSETTS,
METROPOLITAN SEWERAGE COMMISSIONERS, 1 MT. VERNON STREET,
BOSTON, May 9, 1896.

To His Honor the Lieutenant-Governor and the Honorable Council.

Respectfully represents the Board of Metropolitan Sewerage Commissioners that, since the occupation of house No. 1 Mt. Vernon Street by said Board, it is found that it is necessary to have more room in said house for the work of the Board.

Therefore said Board requests that it may have the use and occupation of the fourth and fifth floors in said house.

Very respectfully yours,

(Signed) HOSEA KINGMAN,
Chairman.

To which we received the following reply: —

COMMONWEALTH OF MASSACHUSETTS,
COUNCIL CHAMBER, BOSTON, May 14, 1896.

Hon. HOSEA KINGMAN, *Chairman Metropolitan Sewerage Commission.*

DEAR SIR: — I have the honor to inform you that at a meeting of the Executive Council, held this day, it was ordered that the entire building, No. 1 Mt. Vernon Street, be assigned for the use of the Metropolitan Sewerage Commission, and that the building No. 2 Mt. Vernon Street be assigned for the use of the Boston Transit Commission.

Respectfully yours,

(Signed) E. F. HAMLIN,
Executive Clerk.

Here the office of the Board has remained, at an annual saving of over $3,000.

The following communication speaks for itself: —

COMMONWEALTH OF MASSACHUSETTS,
OFFICE OF THE SECRETARY, BOSTON, Jan. 18, 1896.

EDWD. P. FISK, Esq., *Clerk Metropolitan Sewerage Commissioners.*

DEAR SIR: — I have the honor to inform you that on the ninth day of January, 1896, Hosea Kingman of Bridgewater was appointed and commissioned as a member of the Board of Metropolitan Sewerage Commissioners; and that on the sixteenth day of January, 1896, he took and subscribed the required oaths of office as such commissioner.

Very respectfully,

(Signed) WM. M. OLIN,
Secretary of the Commonwealth.

This is his third appointment as a member of this Board, and upon the completion of said term he will have served ten years thereon.

At the annual meeting of the Board, held, as provided in the act (chapter 439, Acts of 1889), on the first Monday of February (February 3), 1896, Hosea Kingman of Bridgewater was again chosen chairman and Edward P. Fisk clerk for the year.

By chapter 68, Acts of 1892, and also sections 19 and 20 of chapter 407, Acts of 1895, the clerk of this Board, or whomsoever this Board may designate, is allowed to have advanced to him sums not exceeding $10,000 at any one time from the sewerage loan fund in the treasury of the Commonwealth. No provision is made, however, for any such advance from appropriations made for maintaining and operating said systems; and, as the time is not far distant when the work of construction will be completed, we would recommend that an act authorizing similar advances from the appropriations for operating and maintaining these systems be passed.

The recommendations made in this report, summarized briefly, are: the addition of $5,000 to the $30,000 authorized by chapter 414, Acts of 1896, to meet the expenses incurred by adding a part of the town of Wakefield to the metropolitan sewerage system; also the passage of an act (copy submitted to the committee on metropolitan affairs,

1896) authorizing the taking by this Board of the main trunk line of the Boston main drainage system, and making an appropriation therefor (the importance of this has been fully discussed by both this Board and the city authorities, and would, if passed, at once and forever put an end to all conflicting interests, and reduce the cost of maintenance to a minimum); an act authorizing the addition of $300,000 to the $500,000 appropriated by chapter 406, Acts of 1895, for the construction of the Neponset valley sewer; and an act authorizing advances to this Board or its representative from the maintenance funds of the various systems. These acts can be prepared and submitted to the committee of your honorable body authorized to report thereon.

The Appendix contains tables showing in detail the receipts and expenditures for the year, also the assets and liabilities at date.

HOSEA KINGMAN,
TILLY HAYNES,
ALBERT F. NOYES,
Metropolitan Sewerage Commissioners.

Boston, Oct. 1, 1896.

REPORT OF CHIEF ENGINEER

AND

SUPERINTENDENT.

REPORT OF CHIEF ENGINEER

AND

SUPERINTENDENT.

Boston, Sept. 30, 1896.

Hosea Kingman, Tilly Haynes, Albert F. Noyes,
Metropolitan Sewerage Commissioners.

Gentlemen: — The annual report relating to construction and maintenance for the year ending Sept. 30, 1896, is respectfully submitted, as follows: —

The North Metropolitan System has been completed during the year. The coal- and screen-houses which were in process of construction at Deer Island, East Boston and Charlestown, at the close of last year, were completed early in the present year and have been in use since. The pumping plants at the large pumping stations have been formally tested and accepted. The permanent station and pumping plant at Alewife Brook have been in use since November last. A coal-house for this station is just completed. The grounds about all of the stations have been graded, and at Deer Island a heavy sea wall and riprap slope have been placed to defend the coast line fronting the station. The whole system has been in operation during the year, except for minor interruptions at the pumping stations during the formal tests of the pumping plants. It is now receiving through 54 connections the foul drainage from approximately 253.7 miles of local sewers in Deer Island, Winthrop, East Boston, Everett, Malden, Melrose, Medford, Winchester, Woburn, Arlington, Belmont, Cambridge and Somerville. The population now using these sewers is estimated at 98,703 persons. Charlestown, Chelsea and Stoneham, although within the North Metropolitan District, have not as yet made connection with the system.

Surveys have been made for a Wakefield branch of the North Metropolitan System, from the junction of Pleasant Street and

Wyoming Avenue in Melrose, at the end of Section 41, through Melrose to the Wakefield town line. Detailed plans and estimates of cost for this work have been prepared.

The Charles River System, which has been in operation since May 1, 1892, is now receiving through 36 connections foul drainage from approximately 208.4 miles of local sewers in a part of Boston (proper), Brookline, Brighton, Watertown, Newton and Waltham. The population now using these sewers is estimated at 50,540 persons.

In the Neponset Valley approximately 7 miles of intercepting sewer are now in process of construction, extending from Central Avenue in Dorchester to a point in Dedham beyond the Dedham Branch of the New York, New Haven & Hartford Railroad near the West Roxbury line. It is anticipated that this can be opened for service during the coming spring. It will discharge into the Dorchester Intercepter of the Boston Main Drainage System, and will provide for parts of Dorchester, Milton, Hyde Park and Dedham.

Detailed surveys and an estimate of cost for an extension of this intercepter through West Roxbury to near the Brookline town line have been made during the year.

A detailed statement relating to construction and maintenance during the year follows: —

Pumping Station, Deer Island.

Location. — On the south-westerly side and about midway of Deer Island.

Day Work.

Assistants.

Assistant Engineer to April 1, 1896: Frederick D. Smith.
Foreman: Chris Rasmussen.*
Transitman: J. T. P. Jones.*

The work by day labor during the year is as follows: —

Grading grounds about the pumping station and tenement-house; laying a system of surface and house drains; improving graded slopes back of pumping station; constructing sea wall and road in front of the station; improving and cementing the riprap slope fronting the station; and miscellaneous work about the buildings and grounds.

Grading and Drainage. — The grading about the tenement-house involved stripping the loam and raising the surface from 2

* For a portion of the year.

to 4 feet. The loam was afterwards replaced and walks and drives made which were surfaced with beach gravel.

The location of the coal-house and screen-house required that considerable material should be taken away to ensure proper drainage. One hundred and fifty yards of hard pan were removed, the surface was covered with loam, and a system of drains introduced to remove roof- and surface-water. A drain from the tenement-house to the suction wells of the pumping station has also been laid. Cost of grading and drainage, $875.

Slope Back of Station. — The steepness of the slope back of the station and its clayey nature necessitated special precautions to prevent sliding and washing of the loam surface. Timbers have been laid longitudinally at intervals, and the surface of the slope loamed and grassed over. Cost, $75.

Sea Wall. — A sea wall, at the side of the road fronting the station, has been constructed for a distance of 360 feet easterly from the wharf to beyond the end of the station. It is built on a concrete base 3 feet wide by 3½ feet deep below the street surface. The wall is of two courses of cut granite. The lower course is 2 feet wide by 2 feet high, and the upper course, or coping, has a rounded upper surface. Heavy granite newel posts finish the wall at either end. Total cost of wall, $2,039.37.

Improving and Cementing Riprap Slope. — To tighten and strengthen the riprap slope fronting the station the joints have been filled with Portland cement grout, securely sealed against the heel of the sea wall, and otherwise improved. Cost, $175.

Miscellaneous. — Unclassified items, including road-building, concreting cellars of tenement-house, etc., and other day work about the grounds, etc., aggregate in cost (including architect's fees) $1,834.37.

Contract Work.

The following building contracts mentioned in the seventh annual report have been completed during the year: —

Coal-house and Screen-house.

Architect: Arthur F. Gray.
Inspector: Caleb Kimball.
Contractors: Mack & Moore.
Contractors' Foreman: L. F. Sykes.
Contract price: $14,900.

The coal-house is a brick building agreeing in general architectural lines with the engine- and boiler-house and extending

westerly from the boiler-house to the wharf. It provides storage for 600 long tons of coal, and is connected to the end of the wharf by an elevated trestle.

The screen-house is of brick, and is located at the westerly end of the coal-house. It is two stories in height with a slated hip roof surmounted by a cupola. It covers the screen-shaft and contains the machinery for hoisting and pressing.

These buildings were completed Dec. 1, 1895, at a cost of $15,023.31.

Dwelling-house.

Location. — About 150 feet south of the pumping station.

Architect: Ernest N. Boyden.
Inspector: Caleb Kimball.
Contractors:
Building. — Hersee Bros. of Roslindale; contract price, $9,995.
Plumbing. — L. C. Watt of Boston; contract price, $987.

This is a two-story wooden building for four tenements, with a main portion 71 by 30 feet and two wings 18 by 17 feet. Work was commenced on this dwelling Aug. 30, 1895, and was completed Jan. 25, 1896, at a cost of $10,037.72 for the building and $987 for the plumbing.

This house is now fully occupied by permanent employees of the pumping station.

Press for Screen-house. — A press for forming dry cakes, suitable to be burned under the boilers, from the collections removed from the screens, was built by Miller & Shaw of Cambridgeport, at a cost of $195.

Table showing Total Cost of Deer Island Pumping Station and Connections.

Buildings.

Main building, Gooch & Pray,		$24,485 25	
Coal-house, coal-run and screen-house, Mack & Moore,		15,023 31	
Tenement house: —			
General contract, Hersee Bros.,	$10,037 72		
Plumbing contract, L. C. Watt,	987 00		
		11,024 72	
			$50,533 28
Interior finish, engine-room: —			
Wood-work, Wm. Richmond & Co.,		$2,110 00	
Plastering, J. J. Ford & Co.,		275 00	
Marble flooring, Philip H. Butler & Co.,		567 00	
Iron floor work, Chelmsford Foundry Company,		556 70	
Sub-floor of concrete (day work),		351 00	
			3,859 70
Amount carried forward,			$54,392 98

Amount brought forward, ...		$54,392 98
Foundations and Connections.		
Day work: —		
3 pump-wells and foundations for 2 engines, including connections with discharge and low-level sewers, . . .	$24,546 50	
120 linear feet discharge sewer, 6 feet by 10 feet diameter, and building-foundation above it, ...	4,525 25	
86 linear feet low-level sewer (suction chamber), 8 feet by 13 feet, and building-foundation over it, ...	6,535 60	
150 feet low-level sewer, tunnel, ...	6,322 38	
Laying 6-inch water pipe, ...	2,304 18	
Salt-water well, ...	1,419 98	
Screen-chamber, ...	2,140 50	
Grading, retaining wall, riprap, etc., ...	9,515 15	
		57,309 54
Machinery.		
Engines, pumps and boilers, Edward P. Allis Company (including bonus), ...	$55,000 00	
Screen-machinery, ...	2,266 73	
Heating and ventilating, ...	538 00	
		57,804 73
Miscellaneous.		
Unclassified items, including piping, testing of pumping plant, teaming, etc., ...		6,981 55
Total cost of Deer Island pumping station with two pumping engines and appurtenances; the total capacity for pumping being at the rate of 90,000,000 gallons per 24 hours for a lift of 19 feet, . . .		$176,488 80

Section 7 (Day Work), Winthrop and East Boston.

Location. — From a point about 300 feet westerly from Pleasant-street station, on the Boston, Revere Beach & Lynn Railroad, across Belle Isle Inlet and Marsh Island to a point on the marsh in East Boston about 100 feet westerly from Riverside Avenue.

Overflow, Riprap and Grading.

Assistants.

Assistant Engineer: Frank I. Capen.
Foreman: Patrick McCarthy.
Transitman: William M. Stodder.

After the completion of contract work on Section 7 early in 1895, there remained to be constructed an overflow from the end of the sand-catcher on the East Boston shore; also an embankment requiring about 2,900 cubic yards of filling and 900 cubic yards of hand-laid riprap. When this work was completed the approaches to the siphon were left in a safe and sightly condition.

The overflow is a masonry channel 75 feet long, 8 feet wide and 6 feet high, with cut stone mouth; the whole is supported on piles and was built in coffer.

This grading and overflow work was carried out by day labor, and was approximately one-half completed Oct. 1, 1895. It was completed in December, 1895.

Total cost of overflow,	$5,552 44
Total cost of riprap and grading,	5,466 51
	$11,018 95

Pumping Station, East Boston.

Location. — On the northerly side of Addison Street, about 300 feet from the corner of Chelsea and Addison streets, on the south side of Chelsea Creek, east of and adjacent to the Grand Junction Railroad location.

The work of construction at this station, except a few minor items, was completed prior to Sept. 30, 1895.

Sea Wall. — The sea wall at the westerly end of the boiler-house, partially finished last year, was completed in October, 1895. Contractor, W. H. Wyman of Chelsea; cost, $650.

Sidewalk and Grading. — A granite curb and a brick-paved sidewalk 10 feet wide have been completed at the front of the house. Contractors, A. A. Libby & Co. of Boston; cost, $236.74.

Addison Street from Chelsea Street to the easterly end of the station, and the grounds about the ends of the station, have been graded sufficiently to convey the surface- and roof-water away from the buildings and to put the grounds in a smooth and sightly condition. Cost, by day labor, $350.

Hydraulic Lift and Press for Screen-house. — A hydraulic lift was built and erected by the Whittier Machine Company of Boston. This is capable of raising 600 pounds 16 feet, from the level of the screen-pit to screen-room floor. Cost, including wire enclosure, $575.

A steam press for squeezing the material taken from the screens, into dry cakes in condition to be burned under the boilers, was built by Miller & Shaw of Cambridgeport, at a cost of $155.

Table showing Total Cost of East Boston Pumping Station and Connections.

	Buildings.		
Main building, E. E. Strout,	$20,329 18		
Coal-house, W. T. Eaton,	4,610 80		
Screen-house, O'Connell & Furbish,	2,100 00		
		$27,039 98	
Interior finish: —			
Wood-work, William Richmond & Co.,	$1,789 00		
Plastering, J. J. Ford & Co.,	235 00		
Marble flooring, Philip H. Butler & Co.,	510 00		
Iron floor work, Chelmsford Foundry Company,	547 70		
		3,081 70	
Amount carried forward,			$30,121 68

Amount brought forward, ...		$30,121 68
Foundations and Connections.		
Foundations and connections, including screen-man-hole and chamber, suction-conduit, pump-wells and foundations for pumps, discharge-channels and connections with Section 9, sea wall, foundation walls for engine-house, chimney foundations, boiler foundations, wharf, salt-water well, dredging of berth for vessels, etc., . .		67,830 45
Machinery.		
Engines, pumps and boilers, Edward P. Allis Company (including bonus), ...	$57,000 00	
Screen-machinery, ...	1,742 52	
Heating and ventilating, ...	398 00	
		59,140 52
Miscellaneous.		
Unclassified items, including piping, testing of pumping plant, teaming, architect's fees, etc., ...		15,621 29
Total cost of East Boston pumping station with two pumping engines and appurtenances; the total capacity for pumping being at the rate of 90,000,000 gallons per 24 hours for a lift of 19 feet, . . .		$172,713 94

Pumping Station, Charlestown.

Location. — The Charlestown pumping station is located on the easterly side of the Malden Bridge causeway, at the northerly end of the pile structure on what is known as Alford Street, Charlestown.

The foundations for the coal-house at this station were completed by day labor last year. During the present year a brick coal-house with a capacity of 300 long tons has been constructed; the interior finish of the station completed; a heating, ventilating and electric light plant installed; and the grounds about the station graded.

Coal-house.

Architect: Arthur F. Gray.
Inspector: James E. Coyne.
Contractors: Mack & Moore of Boston.
Contract price: $7,400.

The coal-house is located just north of the boiler-house on Alford Street. It is a brick structure, 32½ feet square. The walls are about 17 feet in height, covered with a slated hip roof surmounted by a cupola. The brick and slate match those of the main building. The work of construction was completed Jan. 1, 1896, at a cost of $7,497.

Interior Finish.

The interior finish in the engine- and toilet-rooms consists of dado, doors and window trimmings of oak; tinted, adamant-plastered walls; and granolithic and iron floor. The boiler-room and screen-room are finished in pine with painted walls.

The detailed cost of this work is as follows: —

W. H. Keyes & Co. of Boston, interior wood-work,	$1,857 75
John Mack of Boston, plastering, in accordance with contract,	267 00
Aberthaw Construction Company of Boston, laying 1,819 sq. ft. of granolithic flooring (including labor and materials) at 14 cents per sq. ft.,	254 66
Chelmsford Foundry Company of Boston, iron floor work,	956 20
	$3,335 61

Heating and Ventilating.

The apparatus consists of a 42-inch steel exhaust-fan operated by a direct-connected vertical engine of 3½-inch cylinder and 8-inch stroke, together with a sectional heater having radiating capacity of 1,176 linear feet of 1-inch pipe, with necessary galvanized-iron piping for conveying hot air to engine- and toilet-rooms. The whole was furnished and erected by the Walworth Construction and Supply Company of Boston, at a cost of $405.

Electric Lighting.

The dynamo and engine installed were used during the construction of the tunnel under the Mystic River. They have been thoroughly repaired and much improved.

The dynamo is a direct-current Westinghouse machine, with a capacity of 60 incandescent lights at 110 volts. The engine is an automatic Ideal, with 5-inch cylinder and 6-inch stroke.

The station has been wired for 55 lights in circuits to the engines, boilers, coal-house, screen-house and toilet-rooms, controlled from switches in the dynamo-room.

The wiring and electric work was done by Wilkinson & Feldman of Boston, at a cost of $226.

Grading.

The grounds about the station have been graded to a general agreement with the grades of Alford Street. To protect the masonry wall of the boiler-house, fronting on Alford Street, a fend-log of 12 by 12-inch hard pine has been placed in line with and extended to the fend-log of Malden Bridge. Cost of grading and fend-log, $497.

Table showing Total Cost of Charlestown Pumping Station and Connections.

Buildings.

Main building, Edward Lynch & Co.,	$18,171 31		
Coal-house, Mack & Moore,	7,497 00		
		$25,668 31	
Interior finish: —			
Wood-work, W. H. Keyes & Co.,	$1,857 75		
Plastering, John Mack,	267 00		
Granolithic flooring, Aberthaw Construction Company,	254 66		
Iron floor work, Chelmsford Foundry Company,	956 20		
		3,335 61	
			$29,003 92

Foundations and Connections.

Day work: —			
3 pump-wells,	$44,520 00		
3 inspection- and valve-man-holes,	9,850 00		
Discharge channels to main sewer,	20,700 00		
Foundations for main building,	4,880 00		
Foundations for chimney,	900 00		
Foundations for boilers,	1,000 00		
Foundations for coal-house,	2,675 00		
Sea wall,	15,600 00		
Screen-man-hole,	8,760 00		
Miscellaneous,	8,800 00		
		$117,685 00	
Contract work: —			
Dredging and fender piles, Josiah Shaw,		1,291 00	
			118,976 00

Machinery.

Engines, pumps and boilers, Edward P. Allis Company (including bonus),		$38,000 00	
Screen-machinery,		1,600 00	
Electric wiring and fittings,		226 00	
Heating and ventilating,		405 00	
			40,231 00

Miscellaneous.

Unclassified items, including piping, grading, etc.,	11,543 10
Total cost of Charlestown pumping station with two pumping engines and appurtenances; the total capacity for pumping being at the rate of 45,000,000 gallons per 24 hours for a lift of 11 feet,	$199,754 02

Section 35, Charlestown, Somerville and Medford.

Location. — From Alford Street, at Arlington Avenue, Charlestown, through Arlington Avenue, across the Grand Junction and Boston & Maine Railroad tracks and through Mousal Place to North Union Street; thence through private land to Mystic Avenue near Austin Street, and through Mystic Avenue to a point in Medford a few feet beyond the Somerville and Medford line.

Assistant Engineer: Frank I. Capen.
Transitman: G. A. Winsor.
Contractors: James Heath & Son of Lynn, Mass.

The work at the upper end of this section remaining to be completed Sept. 30, 1895, about 500 feet of sewer 1 foot 10 inches by 2 feet 3½ inches, was finished in January, 1896, and the section was cleaned and opened for service.

The amount of the final estimate for this section was $77,237.97.

Section 38, East Boston.

Location. — From a point in Bremen Street, about 300 feet south of Brooks Street, through Bremen, Decatur, Orleans, Maverick and Jeffries streets to Sumner Street; also a branch from corner of Maverick and Orleans streets, through Orleans and Marginal streets to about 800 feet beyond Cottage Street.

Assistant Engineer: Seth Peterson.
Contractors: James Heath & Son of Lynn, Mass.

At the beginning of the year minor repairs remained to be finished on this section. In Orleans and Marginal streets, near the upper end of the section, the Metropolitan Sewer consists of 15-inch and 18-inch pipe. A length of 20 feet of 15-inch pipe on Orleans Street was found to be badly cracked, and a length of 190 feet on Orleans and Marginal streets was leaking badly. After having been duly notified, the contractors failed to make the necessary repairs and the work was carried out by day labor at the contractors' expense. Total cost of repairs, as outlined above, $748.52.

The cost of repairs to the city of Boston Sewer on Bremen Street, injured by the contractors' operations, and paving on Orleans and Marginal streets, yet remains to be adjusted on this section.

The final estimate on this section was for $45,132.35.

Alewife Brook Pumping Station, North Somerville.

Location. — On the easterly side of Alewife Brook, about 350 feet from the Mystic pumping station of the Boston Water Works.

At the date of the last annual report the station itself was nearly completed. The walls were built and the roof partially slated. The building was finished early in November, 1895. It has been occupied and the pumping plant has been in operation since the end of that month. During the year a riprap slope has been constructed on the bank of Alewife Brook, at the rear of the station; the grounds about the station have been graded; granolithic flooring has been laid in the engine-room and boiler-room; and a coal pocket has been substantially completed.

Coal-pocket. — The pocket is located just north of the boiler-room. It is sunken below the surface, so that its floor is approximately level with the boiler-room floor, and the roof is finished even with the graded surfaces about the station. Four iron hatches in the roof allow coal to be dumped directly from carts into the pocket.

Its dimensions are 40 feet long by 28 feet wide by 6 feet deep. The walls and floor are of Portland concrete, and the roof, supported by iron I-beams, consists of 4-inch brick arches covered with Portland concrete and $1\frac{3}{4}$ inches of asphalt pavement.

The capacity of the pocket is 150 long tons. Total estimated cost, $2,100.

Riprap Slope and Grading. — The riprap slope at the rear of the station, and the grading of the grounds about the station, cost $400.

Granolithic Flooring. — The granolithic flooring was laid by the Aberthaw Construction Company of Boston, at a cost of $104.64.

Miscellaneous. — Iron covers for the suction wells and screen-man-hole cost $150.

Foundations for condensing and feed pumps cost $38.

Pipe-fittings, valve-mechanism in screen-man-hole, and discharge pipes and valves, and miscellaneous iron and piping work about the station, cost $1,823.04.

Pumping Plant.

The station has been designed for four units, two being installed at present. The pumps used are Andrews 9-inch centrifugal, with a maximum capacity of 8 cubic feet per second. The suction pipes are of iron, 10 inches diameter, terminating in a bell 15 inches diameter at the bottom. No foot-valves are used, the pumps being primed by exhausting the air into the condenser. Check-valves on the discharge pipes prevent sewage from running back through the pumps. The pumps are direct-connected to compound-condensing engines of marine type and of about 25 horse-power each, with cylinders 5 inches and 10 inches by 7-inch stroke, running at speeds varying from 280 to 325 revolutions per minute, according to the lift and the quantity pumped.

The engines have cranks hung opposite, to lessen vibration as much as possible. The valves are of the piston-type, with fixed cut-off. An ordinary throttling governor is provided to control the engine in case a pump loses its charge. Should it be desired to run at less than the full capacity of one pump, the steam is throttled or the boiler run at reduced pressure.

The engines were built by the Fore River Engine Company of Weymouth, Mass., and cost (erected) $775 each. The pumps were originally purchased for use on the work of construction, and cost $550 each.

The condensing apparatus consists of two Deane independent vacuum pumps, 3½ inches by 6 inches by 5 inches, connected to a single condenser-bell. The exhaust from the low-pressure cylinders is passed through a Jacobs feed-water heater before reaching the condensers.

The boilers are two in number, of the vertical, tubular type, made with extra high fire-box to allow good combustion of bituminous coal. They are of 48-inch diameter and 12 feet 6 inches high, and contain 100 tubes 2 inches by 6 feet. The fire-box is 42 inches in diameter and 50 inches in height, stayed with 1-inch stay-bolts spaced 5 inches on centres. The boilers are 30 horse-power each, and were designed for a working pressure of 150 pounds per square inch, but are ordinarily run at 125 pounds. The main damper is operated by a Locke damper-regulator.

Two feed pumps of the Deane duplex type, 3 inches by 2 inches by 3 inches each, are provided, together with an injector for an auxiliary feed.

A fixed screen is provided in the low-level sewer, in advance of the suction pipes for pumps, so arranged that any matter collecting on it can be easily raked off.

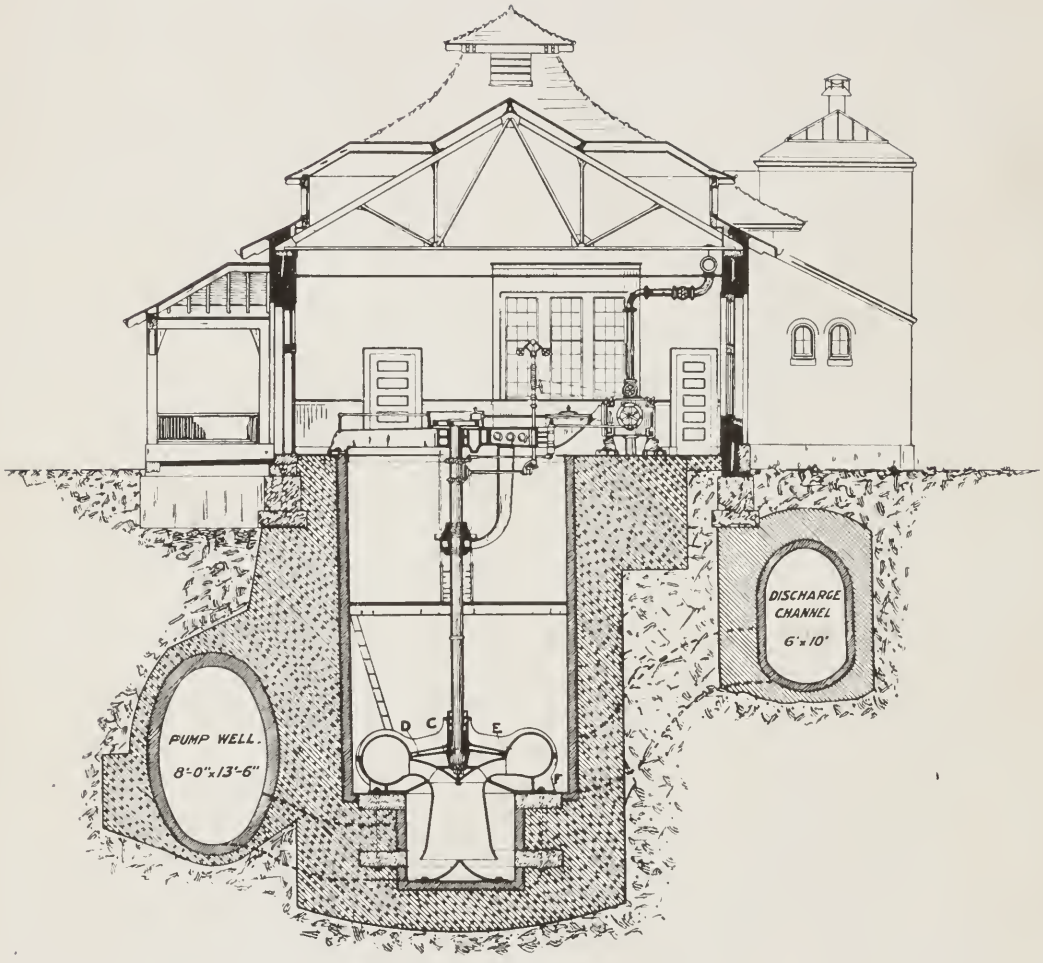
The screen bars are ¾ of an inch diameter, spaced 1 inch apart in the clear.

The design of this station is such that the necessary attendance is reduced as far as possible; one man on each shift is at present sufficient for all the work of running engines and boilers. Outside assistance is required only for the disposal of ashes and matter from the screens.

Table showing Total Cost of Alewife Brook Pumping Station and Connections.

Building (contract of W. T. Eaton of Boston),	$5,719 00
Foundation, pump-wells and 160 linear feet of 3 feet by 3 feet 6 inches connecting sewer (day work),	8,443 33
Coal-pocket (day work), estimated,	2,100 00
Engines,	1,550 00
Boilers,	1,135 00
Feed and condenser pumps and miscellaneous piping,	1,823 04
Miscellaneous unclassified items, including grading, etc.,	2,082 12
Total cost of Alewife Brook pumping station with two pumping engines and appurtenances; the total capacity for pumping being at the rate of 10,000,000 gallons per 24 hours for a lift of 13.6 feet,	$22,852 49

PLATE A



SECTION THROUGH PUMP.

DEER ISLAND STATION.

0 2 4 6 8 10 12 13 20 32

SCALE OF FEET.

Pumping Engine Trials.

The complete pumping plants, including pumps, engines, boilers, piping and all accessories at the three pumping stations at Deer Island, East Boston and Charlestown, were furnished by the Edward P. Allis Company of Milwaukee, Wisconsin.

Deer Island and East Boston Plants. — The general arrangements at the Deer Island pumping station are shown on the accompanying plates (A and B).

The plants at Deer Island and East Boston are of the same capacity and design, and may be described as follows: —

The pumps are of the centrifugal type, with impellers, 8 feet 3 inches in diameter, revolving in a horizontal plane. The discharge pipes are 48 inches in diameter. The suction pipes are bell-shaped, being 66 inches in diameter at the bottom and tapering to 42 inches at the upper end near the pump case. The smallest cross-section of the passages through the impellers is 10 inches wide by 14 inches high, allowing the easy passage of anything that may have passed the screens. The main shafts are vertical, and the weight of impeller, shaft and crank is borne by a thrust-bearing under the main frame of the engine. The engines are horizontal, triple-expansion, condensing, with cylinders of 13½ inches, 24 inches, and 34 inches diameter by 30-inch stroke. They are set so that the centre lines of adjacent cylinders form an angle of 60°.

The valve-gear is of the well-known Reynolds-Corliss type, all three wrist-plates being driven from a single eccentric.

The valve-gears of the intermediate and low-pressure cylinders are provided with adjustable trip cut-offs, which can be set by hand while the engine is running. The high-pressure valve-gear is controlled by an automatic governor, capable of adjustment while running, to give the different engine-speeds that are needed to pump at various lifts and rates of discharge. The valves of the high-pressure and intermediate cylinders are placed in the cylinders in the usual way. The valves of the low-pressure cylinders are placed in the cylinder-heads, in order to reduce clearance space as much as possible. All the cylinder-barrels and the heads of the high-pressure and intermediate cylinders, as well as the receivers, are jacketed with steam at boiler pressure.

The condensers are of the jet type, the single-acting air pump having a diameter of 11 inches and a stroke of 30 inches. The air pump is driven direct by a tail-rod from the intermediate piston. The drip from the jackets is discharged through a Flinn trap into

a small tank, where it is mixed with sufficient fresh water from the city mains to make up the feed, and then returned to the boilers by a small plunger pump actuated by an eccentric on the main shaft. A pair of ordinary, direct-acting, duplex feed-pumps and an injector are also provided for auxiliary boiler-feed.

The boilers are four in number, of the horizontal, return-tubular type, 60 inches diameter and 16 feet long, with 58 tubes, 3½ inches diameter, in each. The heating surface of each boiler is 1,000 square feet.

The grates are of the shaking and dumping type, and have an area of 15.75 square feet for each boiler.

The flue gases are passed through a Green economizer containing 144 tubes, equivalent to about 1,600 square feet of heating surface. A small auxiliary engine is provided for the purpose of running the scrapers of the economizer.

Locke damper-regulators are provided for operating the main dampers.

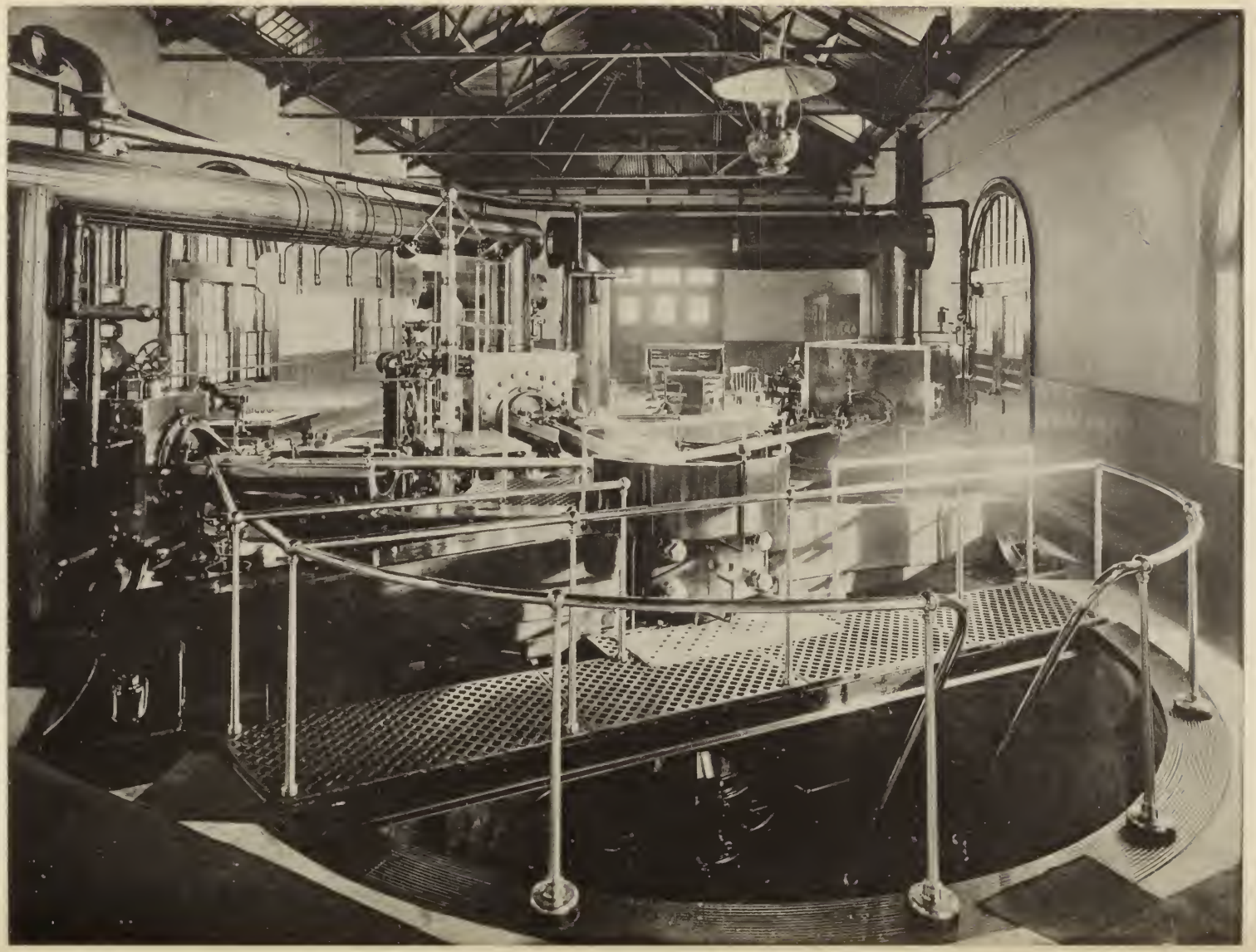
Charlestown Plant. — The plant at this station is similar to the Deer Island and East Boston plants. The engines and pumps are of the same general construction, but are smaller. The engine cylinders are 9¼ inches, 16½ inches and 23 inches diameter by 30-inch stroke. The air-pump is double-acting, 7 inches diameter and 30-inch stroke. The impellers of the pumps are 7 feet 6 inches diameter. The discharge pipes are 36 inches diameter, and suction pipes vary in diameter from 54 inches at the bottom to a minimum of 36 inches near the pump case.

The boilers are two in number, similar in every way to those at the other stations, except that they are 15 feet long, instead of 16 feet, and contain 940 square feet of heating surface each.

The economizer contains 96 tubes, with about 1,050 square feet of heating surface.

The contract for the pumping plant at the Charlestown pumping station contained a special provision that each of the engines at that station must be capable of raising to lifts up to 30 feet quantities of sewage inversely proportional to such lifts. This was for the purpose of pumping out the tunnel under Mystic River, whenever it should be necessary to do so, to avoid the necessity of installing a special plant for that purpose. The pumps were tested, and were found to be able to perform this service either with the shell of the pump unloaded or loaded externally with water.

PLATE B



VIEW OF ENGINE NO. 2. DEER ISLAND.

Contract Requirements.

The contracts contained a provision that each engine should be subjected to trials for capacity and duty, at the expense of the Commonwealth. The conditions to be maintained during the trials were to be as near as practicable those given below. The elevations are in feet, and are referred to a datum about 100.64 feet below mean low water of Boston harbor.

The water to be pumped in the trials was to be either salt water, fresh water or sewage, but was not to contain more than one-half of one per cent. by weight of mineral and organic matter in suspension. Before reaching the suction pipe it was to be screened by a screen having apertures not greater than one inch, measured horizontally.

Trials of Maximum Capacity.

	Pumping Stations.		
	Deer Island.	East Boston.	Charlestown.
Quantity to be pumped (cu. ft. per sec), . . .	70.00	70.00	35.00
Elevation of the surface of water in the pump-well while pumping the above quantity (feet), . .	96.10	92.40	91.00
Elevation of surface of water in discharge channel, beyond outer end of discharge pipe of pump, while pumping the above quantity (feet), . .	115.10	111.40	102.00
Lift (difference between last two elevations) (feet),	19.00	19.00	11.00
Trial to be made of each engine separately, . .	With any 2 boilers.	With any 2 boilers.	With either boiler.
Minimum capacity (cu. ft. per sec.), ...	15.00	15.00	8.00

Duration of maximum-capacity trial to be determined by the Engineer, and to be not less than 12 hours. The quantity discharged to be determined by weir measurement.
Such trials of minimum and intermediate capacity and such trials with lifts greater than the above shall be made as the Engineer thinks necessary.

Duty Trials of Engines and Boilers combined. — To be measured in foot-pounds for each 100 pounds of Georges Creek Cumberland coal, of the best quality, burned. No allowance to be made for ashes or partly consumed coal.

Test to be made with running start and clean fire, 3 inches thick, and to be finished with a fire in a similar condition and engine running.

Foot-pounds of work to be found by multiplying the number of pounds of water pumped by the vertical distance, in feet, between the level in the pump-well and that in the discharge channel, at a point as near as practicable to the end of the discharge pipe of the pump. The quantity discharged to be determined by weir measurement. These trials to be designated " 24-hour coal-duty trials."

Twenty-four-hour Coal-duty Trials.

	Pumping Stations.		
	Deer Island.	East Boston.	Charlestown.
Quantity to be pumped (cu. ft. per sec.), . .	70.00	70.00	35.00
Elevation of surface of water in pump-well while pumping the above quantity (feet), . . .	96.10	93.50	91.00
Elevation of surface of water in discharge channel beyond outer end of discharge pipe while pumping the above quantity (feet), ...	107.10	108.50	99.50
Lift (difference between last two elevations) (feet), ...	11.00	15.00	8.50
Trial to be made of each or either engine by itself, as the Engineer may decide.	Either 1 or 2 boilers.	Either 1 or 2 boilers.	Either boiler.
Duration of trial to be not less than 24 hours.			

Duty Trials of Engines alone. — Duty to be measured by number of foot-pounds of work for each 1,000,000 British thermal units consumed. Number of heat units to be determined in substantial accordance with method recommended by Duty Trial Committee of American Society of Mechanical Engineers, recorded in Vol. XII. of its Transactions. Duration of trial, 10 hours for each or either engine.

These trials to be designated "heat-unit trials of engines." The elevations, lift, rate of pumping and weir measurement to be as in the "24-hour coal-duty trials."

Payments. — If the whole plant at any station be otherwise acceptable, and if the duty developed by said plant in the 24-hour coal-duty trials shall exceed the duty guaranteed by the contractor, a bonus shall be paid above the contract price for said plant; but, the whole plant at any station being otherwise acceptable, if the duty developed by said plant in the 24-hour coal-duty trials shall fall short of the duty guaranteed by the contractor, a fine shall be deducted from the contract price for said plant.

The bonus or fine to be calculated by the following formulæ: —

Deer Island Pumping Station.

$$\text{Bonus} = \frac{\$3{,}800{,}000}{\text{Number of million foot-pounds guaranted.}} - \frac{\$3{,}800{,}000}{\text{Number of million foot-pounds developed.}}$$

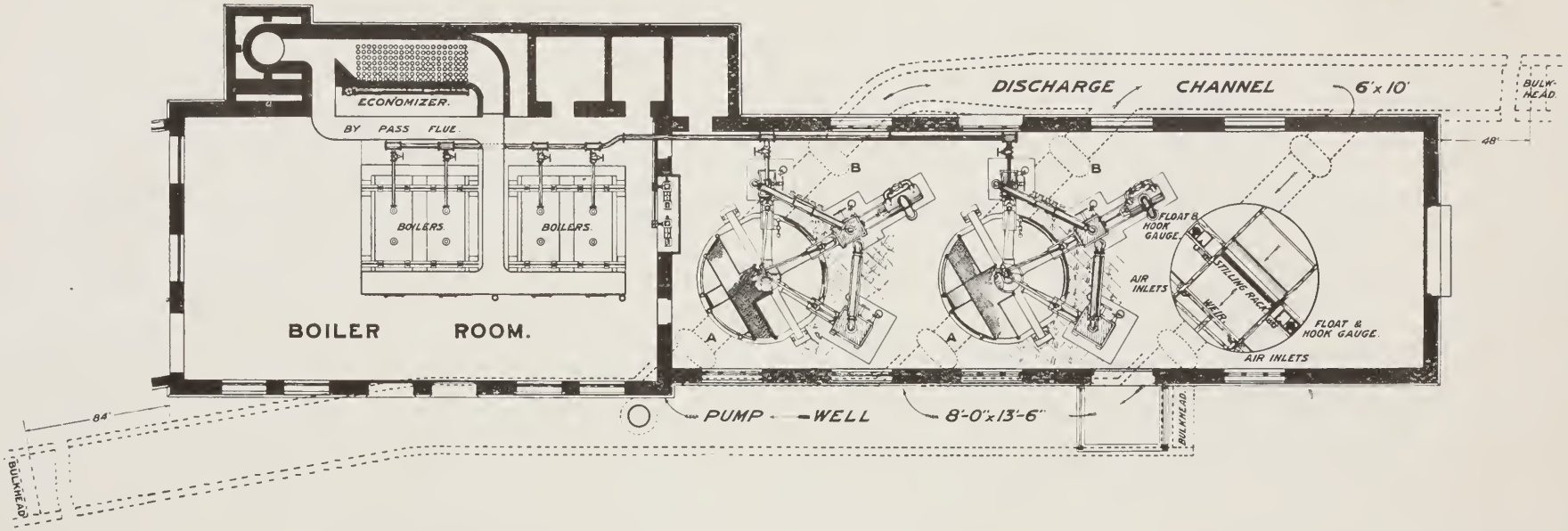
$$\text{Fine} = \frac{\$5{,}300{,}000}{\text{Number of million foot-pounds developed.}} - \frac{\$5{,}300{,}000}{\text{Number of million foot-pounds guaranteed.}}$$

East Boston Pumping Station.

$$\text{Bonus} = \frac{\$5{,}000{,}000}{\text{Number of million foot-pounds guaranteed.}} - \frac{\$5{,}000{,}000}{\text{Number of million foot-pounds developed.}}$$

$$\text{Fine} = \frac{\$7{,}000{,}000}{\text{Number of million foot-pounds developed.}} - \frac{\$7{,}000{,}000}{\text{Number of million foot-pounds guaranteed.}}$$

PLATE C



PLAN OF PUMPING STATION,
DEER ISLAND.

0 5 10 20 30 40 50
SCALE OF FEET.

Charlestown Pumping Station.

$$\text{Bonus} = \frac{\$1{,}300{,}000}{\text{Number of million foot-pounds guaranteed.}} - \frac{\$1{,}300{,}000}{\text{Number of million foot-pounds developed.}}$$

$$\text{Fine} = \frac{\$1{,}800{,}000}{\text{Number of million foot-pounds developed.}} - \frac{\$1{,}800{,}000}{\text{Number of million foot-pounds guaranteed.}}$$

But no bonus shall be paid in excess of the following sums: —

Deer Island pumping station,	$8,000
East Boston pumping station,	10,000
Charlestown pumping station,	3,000

In case the duty developed by the whole plant at any station in either of the trials should fall short of the guaranteed duty by more than 10 per cent., such plant might be rejected.

In the 24-hour coal-duty trials, and in the heat-unit trials of engines, the duty guaranteed by the contractor was as follows: —

Deer Island pumping station,	75,000,000 foot-pounds.
East Boston pumping station,	75,000,000 foot-pounds.
Charlestown pumping station,	70,000,000 foot-pounds.

The contract prices for the pumping plants, not including bonus, were as follows: —

Deer Island pumping station,	$47,000
East Boston pumping station,	47,000
Charlestown pumping station,	35,000

Description of Apparatus and Method of conducting Pumping Engine Trials.

The pumping stations at Deer Island, East Boston and Charlestown are alike in their general plan, but a difference in their surroundings causes a different grouping of parts at each place. The sewage approaches the pumping stations in the low-level sewers, or suction-channels, and leaves them in the high-level sewers, or discharge-channels. These channels are connected with the pump-wells. The third pump-well at each station is now unoccupied, and it was decided to place there the weir by which the discharge of the pumps was to be measured. The general arrangement at the Deer Island pumping station during the tests is shown on the accompanying plate C. A bulkhead was built in the high-level sewer and another in the low-level sewer. A temporary connection at a suitable elevation was made between the third pump-well and the low-level sewer, and the ordinary connection between them was bricked up. Thus the portion of the low-level

sewer between the pumps and the bulkhead was made a tank from which the sewage was pumped and discharged into the high-level sewer, where the upper bulkhead diverted it towards the third pump-well, whence it passed over the weir and flowed back to the suction-channel, to be pumped again over the same circuit. Provision was made for regulating the lift of the pumps by admitting water from the harbor into the suction-channel, or by pumping water out of it.

The liquid pumped during the tests consisted of sewage mixed with the water from the harbor. Samples of the liquid were collected at regular intervals during the tests and their temperatures noted. The specific gravity and weight per cubic foot of the liquid were afterwards determined by Prof. Henry Carmichael of Boston, Mass., analytical and consulting chemist.

The weir and channel of approach were constructed of yellow pine. The weir was vertical and at right angles to the general direction of flow. The crest was a carefully planed wrought-iron plate, flush with the back of the weir, extending entirely across the channel of approach. It was set level and presented a square edge, over which the water flowed with complete vertical contraction, as over a thin plate. The lateral contractions were suppressed. Channels of communication of large size were provided between the external air and the space beneath the sheet of falling water, to equalize the atmospheric pressures on each side of the sheet.

The sides of the channel of approach and the back of the weir below the iron crest were made tight with cement plaster, which was carefully worked to smooth surfaces.

A stilling-rack was placed in the channel of approach about 6 feet back of the weir. The rack was made of planed boards with tapered edges, placed vertically, parallel with the sides of the channel, and spaced about $\frac{7}{8}$ of an inch apart.

A bronze plate was inserted in each side of the channel, with its face flush with the face of the channel. The plates were at mid-depth of the stream and 4 feet 2 inches back of the weir. A sharp-edged circular orifice, bored at right angles to the face of each plate, formed the inlet to a pipe leading to the gauge-box. The orifices and pipes were 3 inches in diameter. A valve was put in each pipe, to control any excessive oscillations of the water.

The gauge-boxes were divided into 2 compartments by a partition reaching nearly to the bottom of the box. The hook-gauges were set in the compartments nearest the weir. The other compartments were occupied by the copper floats of other gauges.

The hook-gauges used in the duty trials were divided into feet

and hundredths, and had verniers reading to thousandths. A bench formed of an iron bolt of suitable shape was established in each gauge-box. The elevation of this bench was determined by direct levelling from the crest of the weir. The point of the hook was then set at the level of the bench by means of a very sensitive spirit-level, and the vernier was adjusted so that the point of the hook should coincide with the level of the crest of the weir when the reading of the gauge was zero. The zero-marks of the hook-gauges were tested before and after each trial, and sometimes during the trials.

Other gauges, in more convenient positions, were also established for watching the general steadiness of the flow. Dial-gauges were used for this purpose at Deer Island and East Boston. They were actuated by a float and weight connected by a cord passing over a pulley. The dial-gauges were not depended upon for accurate observations.

The weir at the Charlestown pumping station was at a great distance below the engine-room floor, and it was decided to use there, instead of dial-gauges, vernier-gauges, consisting of a float carrying a light rod of brass tubing, with an adjustable vernier which moved by the side of a rule attached to a firm support. The vernier read to thousandths of a foot. The motion of the vernier indicated the steadiness of the flow. When it was desired to observe the elevation of the water in the gauge-box by this apparatus, the rod was seized and held firmly by a clamp consisting of two wooden blocks with handles which were grasped by the hand. The accuracy of these gauges was found to be very great, — much greater than that of the dial-gauges. The level of the water was rarely constant, and it was found that the readings of the vernier-gauges agreed sensibly with those of the hook-gauges; which latter had to be set at a given instant to a moving surface.

The dimensions of weirs used in the duty trials were as follows: —

Pumping Stations.	Length of Crest (Feet).	Distance from Crest to Floor (Feet).
Deer Island,	9.989	4.34
East Boston,	9.988	4.30
Charlestown,	7.992	6.98

The formula of Fteley and Stearns was used in computing the discharges over the weir. This formula allows corrections to be made separately for contraction and for velocity of approach.

Some of the experiments made at the time the formula was established also indicate corrections that may be made when the velocities are abnormally distributed. After applying corrections that seemed to correspond most nearly to the conditions obtaining in these trials the formula became : —

$$Q = 3.31\ L\ (H + c\ h)^{\frac{3}{2}} + 0.007\ L$$
$$c = 1.868 - 0.122\ H,$$

in which —

Q is the discharge in cubic feet per second,
L is the length of the weir in feet,
H is the observed depth on the weir in feet,
h is the head due to the mean velocity of approach in feet,
c is a coefficient.

The gauges used in measuring the elevations of the water in the suction and discharge channels each consisted of a copper float carrying a long rod provided with an adjustable index, which traversed the face of a scale divided into feet and hundredths.

The trials were carried out under the immediate direction of Charles H. Swan and Winslow Blanchard, assistant engineers. The contractors were represented by J. H. Lewis, Mechanical Engineer. The observers were employees of the Board.

The readings of steam-, receiver- and vacuum-gauges, engine-counters, temperatures of cold feed, feed entering economizer and feed entering boilers were taken every fifteen minutes during the trials. All gauges and thermometers were carefully compared with standards, and the necessary corrections were applied.

The scales for weighing the coal and feed-water were tested by standard weights, and the necessary corrections were applied.

The readings of the weir-gauges were taken every 5 minutes. The readings of the gauges on the suction and discharge channels were taken every 15 minutes. Samples of the water pumped were taken at regular intervals and the temperatures were noted.

For the 10-hour heat-unit trials the condensed water from the cylinder and receiver jackets was allowed to run to waste, and corrections were made for this loss of heat based on observations of the rise in temperature of the cold feed-water after mixing with the jacket-drip during the 24-hour coal-duty trials.

The feed-water was taken directly from the city mains and sent through the economizer into the boilers. The temperatures used for computing the heat units were those of the cold city water, no allowance being made for heating of the feed by the economizer. The amount of moisture in the steam was assumed to be 1 per cent., this being based on recorded tests on similar boilers in practically the same conditions.

The same water being pumped repeatedly over the weir, carefully conducted experiments were made to determine approximately the amount of free air present in it. The effect of a considerable amount of free air in this water would be to increase somewhat the calculated duty of the pumps. The experiments indicated the presence of such a minute quantity of air that no correction was deemed to be necessary for it.

Results of Trials.

The pumps and engines operated smoothly and satisfactorily throughout the trials. The capacities, duties and amounts to be paid for the plants as determined are as follows: —

	Pumping Stations.		
	Deer Island.	East Boston.	Charlestown.
Capacity required by contract,	70.00 cu. ft. per sec. raised 19 feet.	70.00 cu. ft. per sec. raised 19 feet.	35.00 cu. ft. per sec. raised 11 feet.
Capacity developed during tests: —			
Engine No. 1, . . .	76.47 cu. ft. per sec. raised 19.45 feet.	73.66 cu. ft. per sec. raised 19.55 feet.	37.79 cu. ft. per sec. raised 11.41 feet.
Engine No. 2, . . .	72.54 cu. ft. per sec. raised 19.42 feet.	73.99 cu. ft. per sec. raised 19.59 feet.	38.06 cu. ft. per sec. raised 11.61 feet.
Mean capacity developed, .	74.51 cu. ft. per sec. raised 19.44 feet.	73.83 cu. ft. per sec. raised 19.57 feet.	37.93 cu. ft. per sec. raised 11.51 feet.
Duty guaranteed by contract,	75,000,000 foot-pounds.	75,000,000 foot-pounds.	70,000,000 foot-pounds.
Duty developed during tests: —			
Engine No. 1, . . .	93,761,973 foot-pounds.	91,104,390 foot-pounds.	92,025,790 foot-pounds.
Engine No. 2, . . .	95,867,476 foot-pounds.	92,458,975 foot-pounds.	87,420,358 foot-pounds.
Mean duty developed, . .	94,814,724 foot-pounds.	91,781,682 foot-pounds.	89,723,074 foot-pounds.
Bonus corresponding to mean duty developed, . . .	$10,589 00	$12,190 00	$4,082 60
Maximum bonus allowed by contract, ...	8,000 00	10,000 00	3,000 00
Contract prices, not including bonus, ...	47,000 00	47,000 00	35,000 00
Amounts to be paid for each plant, ...	55,000 00	57,000 00	38,000 00

In comparing these results with those derived from other engines, it should be remembered that the pumps are of the centrifugal type of unusual size, the impellers, or centrifugal fans, being 8 feet 3 inches in diameter at Deer Island and East Boston, and 7 feet 6 inches in diameter at Charlestown. It will further be noted that the duties developed approach the duties of modern,

high-grade piston pumps, and indicate a high degree of perfection in the design and workmanship of the plants. The purpose of the capacity trials being merely to determine whether the plants could easily meet the contract requirements, no attempt was made to attain their limit of capacity. The results of the trials are given more in detail in the following tables: —

Results of Capacity Trials.

	Pumping Stations.					
	Deer Island.		East Boston.		Charlestown.	
	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.
Date of trial,	April 1, 1895.	April 22, 1895.	April 9, 1895.	April 10, 1895.	May 8, 1896.	May 9, 1896.
Duration (hours),	12	12	12	12	12	12
Average discharge, Q (cu. ft. per sec.),	76.47	72.54	73.66	73.99	37.79	38.06
Average lift (feet),	19.45	19.42	19.55	19.59	11.41	11.61
Ratio of Q to contract,	1.0924	1.0363	1.0520	1.0570	1.0800	1.0870
Ratio of lift to contract,	1.024	1.022	1.029	1.031	1.037	1.055
Ratio of work to contract,	1.116	1.060	1.080	1.090	1.119	1.148

Results of Coal-duty Trials.

	Pumping Stations.					
	Deer Island.		East Boston.		Charlestown.	
	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.
Date of trial,	Feb. 27, 1896.	March 2, 1896.	Feb. 6, 1896.	Feb. 10, 1896.	May 16, 1896.	May 13, 1896.
Duration (hours),	24	24	24	24	24	24
Average discharge (cu. ft. per sec.),	72.65	73.13	74.40	73.26	37.99	37.85
Average lift (feet),	11.52	11.55	15.43	15.54	8.89	9.02
Weight per cubic foot of water pumped (pounds),	62.7614	62.7593	62.9680	62.9260	62.9887	62.9760
Net work done in pumping water (foot-pounds),	4,539,017,105	4,579,589,347	6,245,205,934	6,189,236,686	1,839,595,555	1,856,546,154
Net horse-power of water [= total foot-pounds ÷ (24×60×33,000)],	95.50	96.50	131.42	130.00	38.60	39.10
Indicated horse-power of engine,	160.00	155.30	231.20	238.07	76.00	75.00
Ratio of net horse-power of water to indicated horse-power of engine,	0.597	0.621	0.568	0.546	0.508	0.521
Total coal burned (pounds),	5,172	4,954	7,091	6,925	2,050	2,161
Per cent. of moisture in coal,	5.5	3.6	3.3	3.3	2.4	1.7
Total dry coal burned (pounds),	4,881.0	4,777.0	6,855.0	6,694.0	1,999.0	2,123.7
Per cent. of ash and clinker,	2.7	4.6	4.8	4.8	–	1.5
Duty based on total dry coal burned (foot-pounds),	93,761,973	95,867,476	91,104,390	92,458,975	92,025,790	87,420,358
Excess duty above guarantee (foot-pounds),	18,761,973	20,867,476	16,104,390	17,458,975	22,025,790	17,420,358
Bonus based on mean duty,	$10,589 00		$12,190 00		$4,082 60	
Bonus paid (maximum allowed by contract),	8,000 00		10,000 00		3,000 00	

Results of Heat-unit Trials.

	Pumping Stations.					
	Deer Island.		East Boston.		Charlestown.	
	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.	Engine No. 1.	Engine No. 2.
Date of trial,	Feb. 29, 1896.	March 4, 1896.	Feb. 8, 1896.	Feb. 12, 1896.	May 18, 1896.	May 15, 1896.
Duration (hours),	10	10	10	10	10	10
Total revolutions of engine,	42,395	41,703	47,414	48,028	41,330	41,021
Average revolutions per minute of engine,	70.60	69.50	79.02	80.05	68.97	68.40
Average lift (feet),	11.640	11.596	15.425	15.600	8.970	9.030
Average discharge (cu. ft. per sec.),	73.980	72.700	72.280	72.348	38.000	38.495
Average temperature of water pumped (degrees F.),	50.3	51.0	48.7	51.5	56.0	57.0
Weight per cubic foot of water pumped (pounds),	62.7527	62.8325	63.0780	62.8810	62.9510	62.9500
Total water fed to boilers (pounds),	21,931.85	21,049.25	28,818.75	29,605.20	10,207.00	10,179.60
Average temperature of cold feed (degrees F.),	39.43	38.70	37.33	37.28	70.00	62.49
Average temperature of feed entering boilers (degrees F.),	131.5	137.5	160.6	163.4	230.3	221.9
Average pressure of steam (pounds per square inch),	114.30	119.30	115.23	114.37	113.50	114.00
Average pressure first receiver (pounds per square inch),	-	-	22.3	22.6	14.5	15.4
Average pressure second receiver (pounds per square inch),	-	-	—2.10	—1.60	—4.60	—3.13
Average pressure vacuum below atmosphere (pounds per square inch),	-	-	13.8	14.2	13.6	13.0
Barometer (pounds per square inch),	14.65	14.47	14.65	14.75	14.56	14.68
Indicated horse-power,	168.90	160.12	220.00	224.35	76.00	75.25
Feed-water per indicated horse-power per hour,	12.99	13.14	13.10	13.20	13.43	13.53

Wakefield Branch (Sections 49 and 50).

It is directed by chapter 414 of the Acts of 1896 of the Massachusetts Legislature that a branch of the Metropolitan Sewer be extended to Wakefield, to provide for parts of Melrose and the villages of Boyntonville and Greenwood in the town of Wakefield.

The act specifies that so much of the existing main sewer of Melrose is to be acquired, and paid for at its cost to the town, as extends from the Metropolitan main at the corner of Wyoming Avenue and Pleasant Street, through Wyoming Avenue, Berwick, Grove, Myrtle, Essex and Tremont streets to Lake Avenue, in said Melrose. This part of the Wakefield branch will be known as Section 49 of the North Metropolitan System.

The details relating to the sewer to be acquired appear in the following table: —

LOCATION.	Size.		Brick or Pipe.	Average Cut (Feet).
	Diameter (Inches).	Length (Feet).		
Wyoming Avenue,	20	29.24	Brick.	12.50
Wyoming Avenue,	24	16.58	Brick.	12.50
Private land of Boston & Maine Railroad, Berwick and Grove streets,	24	794.81	Pipe.	14.00
Myrtle, Essex and Tremont streets,	18	2,704.25	Pipe.	17.00
Tremont Street to Lake Avenue,	15	343.16	Pipe.	18.00
Total length,		3,888.04		

Regulator and overflow at Wyoming Avenue, and 21 man-holes.

The records of the Board of Sewer Commissioners of the town of Melrose indicate that this length of sewer has cost the town $19,455.03.

The act further specifies that a new sewer shall be constructed through Tremont, Melrose, Belmont, Franklin and Greenwood streets in Melrose to the Wakefield town line. This when constructed will be known as Section 50 of the North Metropolitan System. Early in the year detailed surveys and maps of this route were prepared. Twenty-three pipe soundings have been made to locate accurately the ledge on Greenwood Street, the deep bed of silt which requires piling on Tremont Street, and to ascertain other geological information along the route. The details of Section 50 as required to be constructed are outlined in the following table: —

LOCATION.	Character of Excavation.	Size. Diameter (Inches).	Size. Length (Feet).	Brick or Pipe.	Average Cut (Feet).	Remarks.
Tremont Street, . . .	Sand and gravel; 600 feet peat, .	18	1,000	Pipe.	7.80	7,000 feet piles.
Tremont Street to Franklin Street, ...	Sand and gravel; 300 feet peat, .	15	2,456	Pipe.	11.70	1,800 feet piles.
Franklin and Greenwood streets, ...	Sand and gravel; 900 feet rock, .	12	1,229	Pipe.	10.60	600 cubic yards rock.
Total length, . .			4,685			

The Engineer's estimate of cost for this work, including engineering and contingencies, is $15,097.67.

The act authorizes an appropriation of $30,000 to provide for the purchase of the town sewer and the cost of new construction. As outlined above, the sewer contemplated by the act will cost substantially $5,000 more than the appropriation, and it is recommended that an additional appropriation of this amount be requested.

NEPONSET RIVER VALLEY SYSTEM.

Surveys and maps for an intercepting sewer in the Neponset valley from Central Avenue, Dorchester, to a point in Dedham about 100 feet north-west of the Dedham Branch of the New York, New Haven & Hartford Railroad, covering a distance of about 7 miles, had been prepared and the exact line of the sewer over the route determined as early as March 5, 1896. From this date until July 8, 1896, contracts for its construction were made, and after Aug. 1, 1896, construction was in progress on all the contract sections over the entire route. Approximately, 4 miles of the sewer have now been completed, and, at the present rate of progress, it is likely that the 7 miles above referred to will be in condition for service early in 1897.

It is believed that the present appropriation will cover the cost of the construction now in progress.

Route of the Sewer.

The sewer as built above Central Avenue in Dorchester follows the northerly shore of the Neponset River, generally in private lands, to Mattapan Square; from Mattapan Square to Mattapan Mills, Hyde Park, in River Street; thence in private lands on the westerly shore of the river to Walnut Street, Hyde Park; thence through Walnut Street, Bleakie Mills property, crossing Hyde Park Avenue, through Factory Street, Barry Place, Business and River streets to near the mills of B. B. & R. Knight at the corner of West River Street; thence along the northerly and westerly shore of Mother Brook to Colburn Street in Dedham; through Colburn Street to Maverick Street, and thence along the northerly shore of Mother Brook to Curve Street, through Curve Street to East Street; thence in marsh lands along the Charles River to a point about 100 feet north-west of the Dedham Branch of the New York, New Haven & Hartford Railroad near the West Roxbury line.

Size of the Sewer.

From Central Avenue, Dorchester, to the Hyde Park line, the sewer is 3 feet in diameter for a distance of about 6,470 feet, and 2 feet 6 inches in diameter for a distance of about 1,708 feet, having at its end the full carrying capacity of the Dorchester Intercepter.

Above the Hyde Park line to a point about 50 feet south-east of Wood Avenue on River Street, a distance of about 2,676 feet, the sewer is 4 feet 6 inches in diameter; to the centre of Hyde Park Avenue at the junction of Factory Street, a distance of about 6,462 feet, 4 feet 3 inches in diameter; to about the junction of Maverick and Colburn streets, Dedham, a distance of about 13,263 feet, 4 feet in diameter; to about 100 feet north-westerly beyond the Dedham Branch of the New York, New Haven & Hartford Railroad, a distance of about 5,060 feet, 3 feet 9 inches in diameter.

It is expected that at a later period a large gravity sewer, known as "The High-level Sewer," with an outlet into the Boston Main Drainage System at Squantum or elsewhere, will intercept the Neponset Valley Sewer at or near the Hyde Park line at the lower end of the 4-foot 6-inch section. After that time the 3-foot sewer and the 2-foot 6-inch sewer through Dorchester to Central Avenue will serve permanently for certain low areas in Dorchester and Milton requiring their sewage to be pumped.

Day Work.

For 1,000 feet above Central Avenue the Neponset Intercepter is built through the mill yard and pond of the Tileston & Hollingsworth Company (Eagle Mills). The route is located largely in rock tunnel under and adjacent to tenement-houses, water-conduits and filters. To avoid possible complications with the mill owners during construction this part of the sewer has been built by day labor, and is known as Section 12.

Table of Details.

The remainder of the work is to be constructed by contract, and the details relating to the sections are briefly stated in the following table: —

Section.	Location.	Diameters.	Approximate Length (Feet).	Date of Contract.	Contract awarded to —
12	In Dorchester, from the end of the Dorchester Intercepting Sewer built by the city of Boston to a point in the property of Abba M. Martine.	3′×3′ 1″, . .	986	- -	Day work.
13	From the end of Section 12 to a point in River Street, Dorchester, about 120 feet east of the centre line of Fremont Street.	3′×3′ 1″, . .	3,800	March 21, 1896,	H. P. Nawn, Roxbury, Mass.
14	From the end of Section 13 to a point in River Street, Dorchester, about 270 feet west of Oakland Street.	3′×3′ 1″, . . 2′ 6″×2′ 7″, . .	1,928	March 21, 1896,	H. P. Nawn, Roxbury, Mass.
15	From the end of Section 14, Dorchester, to a point in River Street, Hyde Park, about 20 feet east of Wachusett Street.	2′ 6″×2′ 7″, . 4′ 6″×4′ 7″, .	2,470	March 28, 1896,	H. P. Nawn, Roxbury, Mass.
16	From the end of Section 15 to a point in River Street, Hyde Park, about 620 feet west of Wood Avenue.	4′ 6″×4′ 7″, . 4′ 3″×4′ 4″, .	2,374	March 28, 1896,	H. P. Nawn, Roxbury, Mass.
17	From the end of Section 16 to a point near the junction of Metropolitan Avenue and Pierce Street.	4′ 3″×4′ 4″, .	1,768	April 25, 1896,	George R. Newman & Co., Providence, R. I.
18	From the end of Section 17 to a point in Walnut Street 400 feet south-west of Fairmount Avenue.	4′ 3″×4′ 4′, .	2,720	April 25, 1896,	Troy Public Works Co., Troy, N. Y.
19	From the end of Section 18 to a point in Business Street about 625 feet south-west of Barry Place.	4′ 3″×4′ 4″, . 4′×4′ 1″, . .	2,642	May 2, 1896,	George S. Good & Co., Lock Haven, Pa.
20	From the end of Section 19 to a point in West River Street about 25 feet east of Atherton Street.	4′×4′ 1″, . .	3,228	May 2, 1896,	George S. Good & Co., Lock Haven, Pa.
21	From the end of Section 20, Hyde Park, to a point in Dedham about 1,000 feet west of the town line between Hyde Park and Dedham.	4′×4′ 1″, . .	3,600	June 27, 1896,	Mathers & Sullivan, Washington, D. C.
22	From the end of Section 21 to a point about 550 feet north-west of Mill Lane.	4′×4′ 1″, . .	2,400	June 27, 1896,	Mathers & Sullivan, Washington, D. C.
23	From the end of Section 22 to a point in Colburn Street about 40 feet south-east of Maverick Street.	4′×4′ 1″, . .	2,600	July 1, 1896,	Haskin & Murphy, Charlestown, Mass.
24	From the end of Section 23 to a point in Curve Street about 430 feet east of Washington Street.	4′×4′ 1″, . 3′ 9″×3′ 10″, .	2,470	July 8, 1896,	Haskin & Murphy, Charlestown, Mass.
25	From the end of Section 24 to a point about 100 feet north-west of the Dedham Branch of the New York, New Haven & Hartford Railroad.	3′ 9″×3′ 10″, .	2,670	July 8, 1896,	E. W. Everson, Providence, R. I.
	Total length, Neponset Valley Intercepting Sewer, Sections 12 to 25, inclusive, ...				35,656 feet (6.75 + miles).

Extension of the System through West Roxbury to near the Brookline Town Line.

During the year surveys have been made and detailed maps prepared for the remainder of the intercepter through West Roxbury, as contemplated in the act authorizing the construction. Two hundred and ninety pipe soundings have been made to determine the character of the excavation. The route as selected above Dedham follows generally at the edge of the marsh north and west of the Charles River to Gardner Street, West Roxbury; thence in Gardner Street to the crossing of the Brookline water mains; thence northerly, parallel with the taking of the Brookline Water Works, to Farragut Street; thence in private and marsh lands to Baker Street, through St. Joseph's Cemetery near the brook to La Grange Street; thence easterly along La Grange Street to a brook 250 feet east of Weld Street; thence in the valley of the brook northerly in private lands to Raymond Street near the Brookline town line.

Some additional facts relating to this portion of the sewer appear in the following table: —

LOCATION.	Character of Excavation.	Size.		Brick or Pipe.	Average Cut (Feet).
		Diameter (Inches).	Length (Feet).		
Private land, ...	Peat, sand and gravel, .	45	2,245	Brick.	16.60
Private land, ...	Peat, sand and gravel, .	34	4,880	Brick.	13.80
Private land, Gardner Street, private land, . . .	Peat, sand and gravel, .	32	3,300	Brick.	11.00
Private land, ...	Peat, sand and gravel, .	26	2,108	Brick.	8.60
Private land and La Grange Street, ...	Sand and gravel, . .	20	2,042	Pipe.	9.80
Private land, ...	Peat, sand and gravel, .	15	1,873	Pipe.	9.30
Private land, Brookline Water Works taking,* .	Peat, sand and gravel and ledge, . . .	12	2,207	Pipe.	11.80
Total length, . . .			18,655		

* Brookline Branch.

The Engineer's estimate for this construction, including land rights, engineering and contingencies, is $180,000.

The act authorizing the construction of the Neponset Valley Sewer contemplated the purchase of Sections 9, 10 and 11 of the Dorchester Intercepter of the Boston Main Drainage System, ex-

tending from Central Avenue to Granite Bridge, to provide for connections from the town of Milton. The present cost of these sections to the city of Boston, together with an estimate for unadjusted rights of way, is $106,265.68.

Frank I. Capen, Assistant Engineer, has had immediate charge of the day-work construction on Section 12.

Frederick D. Smith, Assistant Engineer, has had general charge of contract construction in the Neponset Valley.

Surveys and preparation of contract maps for the work have been in charge of Francis L. Sellew, Assistant Engineer.

C. Barton Pratt and Seth Peterson, assistant engineers, have had immediate charge of the sections outlined in the detailed report which follows.

W. G. Crispin, a member of the engineering force employed on surveys in the Neponset Valley, died of pneumonia at his home in Magnolia, Mass., Dec. 6, 1895. He had been connected with this office since July, 1893. He was always faithful and efficient in service and was highly esteemed by all members of the engineering department. This is the second death in the engineering force since its organization.

A detailed report relating to construction in the Neponset Valley follows: —

Section 12, Neponset Valley System (Day Work), Dorchester.

Location. — From the end of the Dorchester Intercepting Sewer, built by the city of Boston, to Central Avenue, through Central Avenue and westerly through the property of the Tileston & Hollingsworth Company (Eagle Mills), across an arm of the mill pond and private land to a point in the property of Abba M. Martine.

Diameter and length of sewer: —

3 feet by 3 feet 1 inch, ... 986.50 feet.

Assistants.

Assistant Engineer: Frank I. Capen.
Foreman: Patrick McCarthy.
Transitmen: Principal — Wm. M. Stodder.
Assistant — F. W. Stockbridge.

Trench and Tunnel.

	3 Feet by 3 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet),	587.00
Length of tunnel excavated to bottom of underdrain (feet),	320.00
Average depth of trench excavation to bottom of underdrain (feet),	16.00
Greatest depth of trench excavation to bottom of underdrain (feet),	18.00
Average width, top of trench (feet),	6.30
Average width, bottom of trench (feet),	6.10
Average depth from surface of ground to bottom of tunnel excavation (feet),	26.00
Greatest depth from surface of ground to bottom of tunnel excavation (feet),	30.00
Average width of tunnel excavation (feet),	5.00
Volume of trench excavation per linear foot (cubic yards),	4.00
Volume of tunnel excavation per linear foot (cubic yards),	1.00

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $8.35.

Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $14.

Character of Excavation. — For the first 212 feet the excavation was in gravel and sand with some rock in the bottom of the trench. This was followed by about 320 feet of rock tunnel. Following this for about 250 feet across the mill pond there were 7 feet of filling, 2 feet of mud, and gravel to grade. For the remainder of the distance the excavation was in loam, filling and gravel.

Diameters of underdrain laid and length of each size: —

4-inch,	280 feet.
8-inch,	348 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.60.

Approximate cost of masonry per linear foot of tunnel, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $4.77.

Length of masonry completed (trench),	573 feet.
Length of masonry completed (tunnel),	60 "

Masonry was begun in trench May 2, 1896, and is now in progress (Sept. 30, 1896).

Masonry was begun in tunnel Sept. 23, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $20.48.

Excavation. — An open-cut excavation was started at the end of the Dorchester Intercepting Sewer in Central Avenue on April 9, 1896, and extended southerly for 212 feet. In the yard of the Tileston & Hollingsworth Company a tunnel shaft near Station 3+0 was commenced on April 15, 1896, and a tunnel extended backward about 100 feet and forward about 150 feet. On June 11, 1896, an open-cut excavation was started at the upper end of the section in the Martine estate, which was worked backward 362

feet, about 250 feet of this distance being across an arm of the Eagle Mills pond. At the end of this section crossing the pond a tunnel heading was started Aug. 25, 1896, which was worked northerly toward the first-named shaft at Station 3+0, that had been started April 15. This tunnel is still unfinished. At the shafts a siphon ejector raised the ground-water. At the open-cut excavation started on April 9, 1896, at the beginning of the section, but a slight amount of ground-water was encountered, and this was drained for a short time into the Dorchester Intercepter in Central Avenue. At the open-cut excavation at the end of the section the water in the trench was handled by contractor's pump on Section 13.

Foundation. — The foundation has been either of clay and gravel, or rock, except under the mill pond, where coarse gravel was found.

Difficulties. — Crossing the mill pond an embankment was built with its surface about 1 foot above high-water mark. It was about 8 feet wide on top with natural slopes. After the embankment had settled a trench was excavated in it. Two-inch matched sheeting was used. No special difficulty was found in crossing the pond in this manner. The water was drained through an 8-inch pipe.

On the tunnel work the close proximity to buildings, cisterns and filters of the Eagle Mills made it necessary to exercise great caution in blasting. Very light charges of explosive only could be used. The rock was exceedingly hard, requiring the loading of many of the holes more than once, the consequence being a very slow rate of progress.

Miscellaneous. — After the sewer across the mill pond was constructed, the embankment was graded with surplus earth to an elevation about 3 feet above the ordinary surface of the pond. As completed the embankment is 8 feet wide at the top with slopes, 1½ to 1, paved with riprap of surplus rock from the tunnel excavation.

An opening 25 feet in width has been left, midway of the embankment, for the passage of boats. Here the arch of the sewer is reinforced with 8-inch granite blocks anchored into the concrete masonry of the invert. The water at this opening is about 3 feet deep over the sewer arch.

Section 13 (Neponset Valley System), Dorchester.

Location. — From a point in private land, on the southerly bank of the Neponset River, about 1,000 feet west of Central Avenue, extending westerly in proposed streets through private land of John Conness and Thomas Liversidge estate to River Street, a distance of about 2,900 feet; thence in River Street to about 120 feet east of the centre line of Fremont Street; a total distance of 3,800 feet.

Diameter and length of sewer: —

3 feet by 3 feet 1 inch, ... 3,800 feet.

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as his own superintendent.

Contractor's Principal Foremen. — John Ellwood, Patrick Foley, Frank Riley.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.

Inspectors: Caleb Kimball, S. B. Horton, Charles Roesbeck, Chris Rasmussen, John Craib.

Transitmen: Principal — Charles H. Smith, Charles Kincaid, G. E. Stratton, Henry Cleary.

Assistant — M. F. Sanborn, Leon Alland, Mark E. Taylor, Walter Cleary.

Trench and Tunnel.

	3 Feet by 3 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . . .	3,403.00
Length of tunnel excavated to bottom of underdrain (feet), . . .	260.00
Average depth of trench excavation to bottom of concrete (feet), . .	11.80
Greatest depth of trench excavation to bottom of concrete (feet), . .	20.90
Average width, top of trench (feet), ...	5.50
Average width, bottom of trench (feet), ...	5.40
Average depth from surface of ground to bottom of tunnel concrete (feet), ...	18.60
Greatest depth from surface of ground to bottom of tunnel concrete (feet), ...	26.80
Average width of tunnel excavation (feet), ...	5.70
Volume of trench excavation per linear foot (cubic yards), . . .	2.40
Volume of tunnel excavation per linear foot (cubic yards), . . .	1.30

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $3.79.

Approximate cost of tunnel excavation per linear foot to date (Sept. 30, 1896), $7.

Character of Excavation. — For 180 feet from beginning of section, 1 foot loam, sand, gravel and boulders to grade; then for 250 feet, 1 foot loam, then sand and gravel to ledge, averaging about 5 feet deep in the bottom; then for 318 feet, 1 foot loam with sand and gravel to grade; then for 82 feet, a rock tunnel. From a point about 962 feet from the beginning of the section, tunnel through sand, gravel and boulders for 178 feet; from this point the trench begins again with 1 foot loam, 6 feet sand and gravel, then fine sand to grade, extending for 500 feet, changing here to loam, sand and gravel for 1,500 feet, at which point the excavation was through 1½ feet road-bed, then sand and gravel with a bottom of ledge for 220 feet, changing again to road-bed, then sand, clay and gravel for 440 feet to the end of the section.

* The above-named State assistants have been employed for part of the time only on Section 13.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard (trench),	$12 50
Brickwork, American cement mortar, per cubic yard (tunnel),	15 00
Brickwork, Portland cement mortar, per cubic yard (trench),	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	16 00
Concrete, American cement mortar, per cubic yard (trench),	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	7 00

Diameters of underdrain laid and length of each size: —

6-inch,	471 feet.
8-inch,	2,896 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $4.11.

Length of masonry completed (trench), 3,331 feet.

Masonry begun in trench April 16, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $8.29.*

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* To Sept. 30, 1896, no masonry has been built in tunnel on Section 13.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.	Opening No. 5.	Opening No. 6.
Character of opening,	Open cut,	Tunnel,	Open cut,	Tunnel,	Open cut,	Open cut.
Number of tunnel headings,	- -	One,	- -	One,	- -	- -
Date of starting,	April 6, 1896,	July 8, 1896,	May 13, 1896,	July 8, 1896,	May 14, 1896,	July 1, 1896.
Point of beginning,	Beginning of section.	748 feet from beginning of section.	1,623 feet from beginning of section.	1,140 feet from beginning of section.	1,623 feet from beginning of section.	In River Street, 2,940 feet from beginning of section.
Point of ending or where work was in progress Sept. 30, 1896,	748 feet from beginning of section.	836 feet from beginning of section.	1,140 feet from beginning of section.	986 feet from beginning of section.	In River Street, 2,940 feet from beginning of section.	In River Street, 3,800 feet from beginning of section.
Date of finishing,	July 8, 1896,	In progress Sept. 30, 1896.	July 6, 1896,	In progress Sept. 30, 1896.	July 27, 1896,	Sept. 3, 1896.
Length,	748 feet,	88 feet,	483 feet,	154 feet,	1,317 feet,	860 feet.
Ordinary progress per week,	70 feet,	9 feet,	60 feet,	16 feet,	130 feet,	90 feet.
Appliances used,	Hand labor,	Wheelbarrows,	Hand labor,	Wheelbarrows,	Hand labor,	Hand labor.
Size of gang ordinarily employed,	30 men,	8 men,	25 men,	8 men,	30 men,	27 men.

The ground-water was handled by two 6-inch centrifugal pumps, one at the beginning of the section and one at a point 1,623 feet from the beginning. At the first-named point the greatest rate of pumping was about 200,000 gallons in 24 hours; at the second point, about 300,000 gallons.

Foundation. — For considerable portions of this section the soil in the bottom of the trench has been loose sand and gravel, this formation being of such a nature that it could not safely be shaped to fit the invert of the sewer. A foundation of American concrete has been generally used. In ledge the sewer has been laid with an American concrete invert 6 inches in thickness on the bottom and 8 inches on the sides at the springing line. A 4-inch brick invert has been laid in the concrete. The arch of the sewer throughout the section has been 8 inches in thickness.

Surplus Material. — The surplus earth has been used for filling low areas of land within the Liversidge estate, adjacent to the line of the sewer. A road leading to the rear of the institution on this estate has been partially graded with surplus rock from the section.

Section 14 (Neponset Valley System), Dorchester.

Location. — From a point in River Street, about 120 feet east of the centre line of Fremont Street, extending south-westerly in River Street, through private and railroad lands, and through Mattapan Square and River Street to a point about 270 feet west of Oakland Street.

Diameters of sewers and length of each size: —

3 feet by 3 feet 1 inch,	1,689 00 feet.
2 feet 6 inches by 2 feet 7 inches,	239.53 "

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as his own superintendent.

Contractor's Principal Foremen. — J. B. Cummerford, Frank Riley.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.

Inspectors: H. M. Woodward, H. E. Tatro, Charles Roesbeck, S. B. Horton.

Transitmen: Principal — C. H. Smith, Henry Cleary, Charles Kincaid, G. E. Stratton.

Assistant — Leon Alland, M. F. Sanborn, Mark E. Taylor.

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* The above-named State assistants have been employed for part of the time only on Section 14.

Trench.

	3 Feet by 3 Feet 1 Inch Sewer.		2 Feet 6 Inches by 2 Feet 7 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	520	1,169	239.50
Average depth of trench excavation to bottom of concrete (feet),	5.40	15.00	14.30
Greatest depth of trench excavation to bottom of concrete (feet),	8.00	21.30	18.00
Average width, top of trench (feet),	6.20	5.60	5.70
Average width, bottom of trench (feet),	6.00	6.20	4.80
Volume of trench excavation per linear foot (cubic yards),	1.20	3.30	2.80
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, backfilling, etc., to date (Sept. 30, 1896),	$2 71	$6 44	$2 40

Character of Excavation. — For the first 75 feet, filling, sand, gravel and clay to grade; then for the next 465 feet, about 3 feet of mud, then sand, gravel and clay to grade, changing to sand, gravel and boulders with wet sandy clay to grade for a distance of 288 feet; here the excavation changes to sand, gravel and boulders under which ledge was found for a distance of 832 feet, merging into 2 feet filling, 1 foot loam, sand, clay and gravel to grade for a distance of 268 feet to end of section.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard (trench),	$12 50
Brickwork, Portland cement mortar, per cubic yard (trench),	14 00
Concrete, American cement mortar, per cubic yard (trench),	5 00
Concrete, Portland cement mortar, per cubic yard (trench),	7 00

Diameters of underdrain laid and length of each size: —

6-inch,	1,012.5 feet.
8-inch,	916.0 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.22.

Length of masonry completed (trench), 1,928.5 feet.

Masonry begun in trench April 13, 1896; finished Sept. 30, 1896.

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $10.49.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Open cut,	Open cut,	Open cut.
Date of starting,	April 6, 1896,	July 13, 1896,	July 31, 1896.
Point of beginning,	In private way just beyond Burt estate, about 586 feet from beginning of section.	About 250 feet south-west of south-westerly side of Mattapan Square.	In private way just beyond Burt estate, about 586 feet from beginning of section.
Point of ending,	Mattapan Square,	Mattapan Square,	In River Street, about 120 feet east of the centre line of Fremont Street.
Date of finishing,	Sept. 17, 1896,	Sept. 24, 1896,	Aug. 28, 1896.
Length,	1,062 feet,	280.5 feet,	586 feet.
Ordinary progress per week,	48 feet,	30 feet,	146 feet.
Appliances used,	By hand labor and steam derrick.	Hand labor,	Hand labor.
Size of gang ordinarily employed,	31 men,	16 men,	26 men.

The ground-water was taken care of as follows: for 280 feet, at the end of the section, the water was removed by a pulsometer located in a well used jointly for sections 14 and 15; a second pump-well was located about 586 feet from the beginning of Section 14, where the water was removed by hand-pumps.

Foundation. — Through the private way, about 720 feet from the beginning of the section, the bottom of the trench was excavated to fit the invert of the sewer for a distance of about 53 feet, where the soil was hard, sandy clay and fine gravel.

Through the private way, 586 feet from the beginning of the section, for a distance of 137 feet, it was found necessary to excavate to a depth of 2 feet below the water line of the sewer and refill with gravel, as the original soil for this length consisted of wet, sandy clay.

The soil in the bottom of the trench, other than as heretofore stated, consisted of sand, gravel and clay, and rock. Where this formation was encountered the sewer was built with concrete invert about 6 inches in depth on the bottom and 8 inches in thickness on the sides, together with 4-inch brick invert and arch of 8-inch brick masonry.

Difficulties. — Near its lower end this section passes through a flowed area, adjacent to the Neponset River, sometimes covered with one or two feet of water. The excavation was through $2\frac{1}{2}$ feet of mud, followed by sand and gravel to grade. Dikes of the excavated material excluded the river from the trench, and the water then entering it was readily controlled by hand-pumps.

For 520 feet in this locality the crown of the sewer arch is about 2 feet below the surface of the ground. Here the sewer was built with a reinforced section. A 4-inch invert and an 8-inch arch, both of Portland brick masonry, were built in a Portland concrete invert. The sewer was back-filled with Portland concrete to a depth of about 8 inches over the crown of the arch, in which curved sheets of expanded metal were placed. The sheets were 4 feet wide by 6 feet long, of No. 16 gauge and 4-inch mesh. They were held in place in the concrete by 8-inch channel irons 3 feet long, and securely anchored into the invert masonry by bolts 4 feet 6 inches long and of $\frac{3}{4}$-inch diameter.

Surplus Material. — The surplus earth has been used for filling low lands adjacent to the line of the sewer.

Section 15 (Neponset Valley System), Dorchester and Hyde Park.

Location. — From a point in River Street, Dorchester, about 270 feet west of Oakland Street, extending westerly through River Street to a point in Hyde Park about 20 feet east of Wachusett Street.

Diameters of sewers and length of each size: —

2 feet 6 inches by 2 feet 7 inches, ... 1,464.00 feet.
4 feet 6 inches by 4 feet 7 inches, ... 1,006.30 "

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as his own superintendent.

Contractor's Principal Foremen. — Robert Eager, William Hall.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.
Inspectors: Michael Garra, C. G. Waite, John Craib.
Transitmen: Principal — Charles H. Smith, Henry Cleary, G. E. Stratton, Charles Kincaid.
Assistant — M. F. Sanborn, Leon Alland, Mark E. Taylor.

Trench and Tunnel.

	2 Feet 6 Inches by 2 Feet 7 Inches Sewer.	4 Feet 6 Inches by 4 Feet 7 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	1,464.00	507.00
Length of tunnel excavated to bottom of underdrain (feet),	–	429.30
Average depth of trench excavation to bottom of concrete (feet),	15.60	18.90
Greatest depth of trench excavation to bottom of concrete (feet),	17.40	19.20
Average width, top of trench (feet),	5.50	8.60
Average width, bottom of trench (feet),	5.00	6.70
Average depth from surface of ground to bottom of tunnel concrete (feet),	–	24.90
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	–	27.40
Average width of tunnel excavation (feet),	–	7.00
Volume of trench excavation per linear foot (cubic yards),	3.00	5.40
Volume of tunnel excavation per linear foot (cubic yards),	–	2.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896),	$5 45	$6 98
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896),	–	12 00

Character of Excavation. — For the first 60 feet, 2 feet street surfacing, clay, sand and gravel to grade; for the next 180 feet, 2 feet street surfacing, 4 feet sand, sand, clay and gravel, with ledge in the bottom; then for 272 feet, 2 feet surfacing,

* The above-named State assistants have been employed for part of the time only on Section 15.

4 feet sand, then sand, gravel and boulders to grade; for the next 356 feet, street surfacing, 2 feet sand, gravel and boulders on top of ledge varying from 1 to 9 feet in depth; then for the next 738 feet, 1 foot street surfacing, 1 foot loam, sand, gravel, clay and boulders to grade; for the next 174 feet, 1 foot filling, 2 feet sandy loam and gravel, 7 feet sand and gravel, then sand, gravel, clay and boulders, with ledge in the bottom; then for 191 feet, street filling, 1 foot sandy loam, 6 feet coarse sand, then sand, gravel, clay and boulders, with ledge in the bottom. The 429.30 feet of tunnel on this section was excavated through ledge.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard (trench),	$12 50
Brickwork, American cement mortar, per cubic yard (tunnel),	15 00
Brickwork, Portland cement mortar, per cubic yard (trench),	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	16 00
Concrete, American cement mortar, per cubic yard (trench),	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	6 00
Concrete, Portland cement mortar, per cubic yard (trench),	7 00
Concrete, Portland cement mortar, per cubic yard (tunnel),	8 00

Diameters of underdrain laid and length of each size: —

6-inch,	1,006 feet.
8-inch,	790 "
10-inch,	64 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $4.65.

Length of masonry completed (trench), 1,560 feet.

Masonry begun in trench April 21, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $11.74.*

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Open cut,	Tunnel,	Tunnel.
Number of tunnel headings,	- -	One,	Two.
Date of starting,	April 6, 1896,	April 25, 1896,	July 28, 1896.
Point of beginning,	Lower end of section.	In River Street about 20 feet east of Wachusett Street.	About 80 feet westerly from Holmfield Ave.
Point where work was in progress Sept. 30, 1896,	1,971 feet from beginning of section.	273.3 feet east of Wachusett Street.	About opposite the centre line of Holmfield Avenue and about 176 feet west of Holmfield Avenue.
Length,	1,971 feet,	253.3 feet,	176 feet.
Ordinary progress per week,	73 feet,	12 feet,	24 feet.
Appliances used,	Carson trench machine.	Steam derrick,	Steam derrick.
Size of gang ordinarily employed,	36 men,	6 men,	12 men.

* To Sept. 30, 1896, no masonry has been built in tunnel on Section 15.

The ground-water was raised by two 4-inch pulsometer pumps and one 6-inch centrifugal pump. A well was located about 60 feet from the beginning of the section, where one of the pulsometers handled the water for the lower 1,100 feet of the section. A second well was located about 1,100 feet from the beginning of the section, where the second pulsometer took care of the water for the next 300 feet. At this point a spring was encountered in the bottom of the trench, necessitating a third well and the use of a 6-inch centrifugal pump to the end of the section. In addition, hand-pumps were occasionally used.

Foundation. — Near the beginning of the section, for a distance of 449 feet, the bottom of the trench has been excavated to fit the invert of the sewer in a formation of clay, sand and gravel. For the balance of the section the bottom of the trench was of sand, gravel, boulders or ledge, necessitating the building of an invert of American concrete 6 inches in depth on the bottom and 6 inches in thickness on the sides. The brick invert of the sewer was then laid with Portland cement mortar. The flooding of the trench by a spring, above noted, about 1,450 feet from the beginning of the section, near the Hyde Park line, was the only special difficulty of the section. Up to Sept. 30, 1896, the maximum pumpage at this point is estimated at 800,000 gallons per 24 hours.

Section 16 (Neponset Valley System), Hyde Park.

Location. — From a point in River Street, Hyde Park, about 20 feet east of Wachusett Street, extending south-westerly through River Street across the New England Railroad and railroad property; thence into River Street, about opposite Radcliffe Road, extending through River Street to a point about 620 feet west of Wood Avenue.

Diameters of sewers and length of each size: —

4 feet 6 inches by 4 feet 7 inches,	1,690 feet.
4 feet 2 inches by 4 feet 3 inches,	684 "

Contractor. — Harry P. Nawn of Roxbury, Mass. Mr. Nawn has acted as his own superintendent.

Contractor's Principal Foremen. — William Hall, Peter Mally.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.
Inspector: Michael Garra.
Transitmen: Principal — Henry Cleary, Charles H. Smith, Charles Kincaid, G. E. Stratton.
Assistant — Leon Alland, M. F. Sanborn, Mark E. Taylor.

* The above-named State assistants have been employed for part of the time only on Section 16.

SECTION 16, HYDE PARK. VIEW IN SAND TUNNEL, SEPT. 28, 1896.

Trench and Tunnel.

	4 Feet 6 Inches by 4 Feet 7 Inches Sewer.	4 Feet 2 Inches by 4 Feet 3 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	490.00	98.00
Length of tunnel excavated to bottom of underdrain (feet),	385.00	-
Average depth of trench excavation to bottom of concrete (feet),	26.40	20.50
Greatest depth of trench excavation to bottom of concrete (feet),	27.60	20.80
Average width, top of trench (feet),	9.00	8.60
Average width, bottom of trench (feet),	7.10	6.60
Average depth from surface of ground to bottom of tunnel concrete (feet),	27.90	-
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	34.40	-
Average width of tunnel excavation (feet),	7.20	-
Volume of trench excavation per linear foot (cubic yards),	7.90	5.80
Volume of tunnel excavation per linear foot (cubic yards),	1.80	-
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896),	$16 05	$6 00
Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896),	13 90	-

Character of Excavation. — From a point at the beginning of the section in River Street, about 20 feet east of Wachusett Street, the excavation was by tunnel, through ledge, for a distance of 207 feet; then open cut through sand and gravel on top of ledge from 1 to 27 feet in depth for a distance of 280 feet; then open cut with sand, gravel and boulders for 65 feet; then tunnel for 96 feet with sand, gravel and boulders; then open cut for 145 feet through 1 foot loam, 8 feet sand and gravel; then fine sand to grade. Tunnel, 82 feet with sand, gravel and boulders. At a point in River Street about opposite the south-westerly side of Wood Avenue, and for a distance of 98 feet, 2 feet of street surfacing, then sand, gravel and small boulders to grade.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 50
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size: —

6-inch,	545 feet.
8-inch,	397 "

Approximate cost of masonry per linear foot of trench and tunnel, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $8.94.

Length of masonry completed (trench),	371 feet.
Length of masonry completed (tunnel),	96 "

Masonry begun in trench May 30, 1896, and is now in progress (Sept. 30, 1896).

Masonry begun in tunnel June 23, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $14.35.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.	Opening No. 5.	Opening No. 6.
Character of opening,	Tunnel,	Open cut,	Tunnel,	Open cut,	Tunnel,	Open cut.
Number of tunnel headings,	One,	– –	Two,	– –	One,	– –
Date of starting,	April 6, 1896,	May 14, 1896,	April 10, 1896,	June 29, 1896,	Aug. 3, 1896,	Sept. 3, 1896.
Point of beginning,	At the beginning of the section, about 20 feet east of Wachusett Street.	About 85 feet east of the easterly side of New England Railroad tracks in railroad property.	85 feet east of easterly side of New England Railroad tracks in railroad property.	11 feet west of westerly side of New England Railroad tracks in railroad property.	Southerly line of River Street, 192 feet west of westerly side of New England Railroad tracks.	In River Street, opposite westerly side of Wood Avenue.
Point of ending or where work was in progress Sept. 30, 1896,	In River Street, about 227 feet east of Wachusett Street.	In River Street, about 227 feet east of Wachusett Street.	11 feet west of westerly side of New England Railroad tracks in railroad property.	On south line of River Street, 192 feet west of west side of railroad track.	In River Street, 80 feet west of westerly line of Radcliffe Road.	In progress Sept. 30, 1896, at a point 98 feet westerly from Radcliffe Road in River Street.
Date of finishing,	Sept. 21, 1896,	Sept. 30, 1896,	Aug. 21, 1896,	Aug. 3, 1896,	Aug. 27, 1896,	In progress Sept. 30, 1896.
Length,	207 feet,	345 feet,	96 feet,	145 feet,	82 feet,	98 feet.
Ordinary progress per week,	12 feet,	18 feet,	8 feet,	36 feet,	17 feet,	29 feet.
Appliances used,	Stiff-leg derrick with engine.	Double stiff-leg derrick with one engine.	Derrick and engine,	Derrick and engine,	Derrick and engine,	Carson Trench Machine.
Size of gang ordinarily employed,	7 men,	16 men,	7 men,	14 men,	7 men,	14 men.

The ground-water was first removed by a 3-inch siphon ejector used at the shaft near the beginning of the section; later, a 6-inch Knowles pump was used here. Then a well was made at the side of the shaft near the railroad, and a No. 3 pulsometer pump removed the water from the tunnels and open cuts beyond.

Foundation. — An invert of 4-inch Portland brick masonry has been laid in a bed of American concrete, 6 inches in depth on the bottom and from 6 to 8 inches in thickness at the springing line, for the whole section.

Difficulties. — No special difficulties have been encountered on this section. The arch of the sewer in tunnel under the New England Railroad tracks, near the River-street station, Hyde Park, has been back-filled with American concrete. In open cut at both ends of tunnel under railroad, near River-street station, passing the slope of the highway embankment, the arch of the sewer has been reinforced by concrete spandrels.

Surplus Material. — The surplus material from the excavations has been used in filling land adjacent to the line of the sewer.

Section 17 (Neponset Valley System), Hyde Park.

Location. — From a point in River Street, Hyde Park, near Mattapan Mills, about 620 feet west of Wood Avenue, extending through River Street and private lands, along the Neponset River to a point near the junction of Metropolitan Avenue and Pierce Street.

Diameter and length of sewer: —

4 feet 3 inches by 4 feet 4 inches, ... 1,767.80 feet.

Contractors. — George R. Newman & Co. of Providence, R. I.
Contractors' Superintendent. — Charles L. Mowry.
Contractors' Principal Foreman. — Frank Brundage.

*State Assistants.**

Assistant Engineer: C. Barton Pratt.
Inspectors: B. L. Sykes, John D. Collins.
Transitmen: Principal — Henry Cleary, G. E. Stratton, Charles Kincaid, Charles H. Smith.
Assistant — Leon Alland, M. F. Sanborn, Mark E. Taylor.

* The above-named State assistants have been employed for a part of the time only on Section 17.

Trench and Tunnel.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	926.00
Length of tunnel excavated to bottom of underdrain (feet),	172.00
Average depth of trench excavation to bottom of concrete (feet),	16.00
Greatest depth of trench excavation to bottom of concrete (feet),	31.30
Average width, top of trench (feet),	7.60
Average width, bottom of trench (feet),	7.20
Average depth from surface of ground to bottom of tunnel concrete (feet),	30.40
Greatest depth from surface of ground to bottom of tunnel concrete (feet),	32.60
Average width of tunnel excavation (feet),	5.30
Volume of trench excavation per linear foot (cubic yards),	4.40
Volume of tunnel excavation per linear foot (cubic yards),	1.50

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $11.59.

Approximate cost of tunnel excavation per linear foot, including excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $12.75.

Character of Excavation. — The 172 feet of tunnel in River Street was through very hard ledge. The open cut, which began in proposed street in Sumner estate, about 75 feet south of south side of River Street, was excavated through about 1½ feet loam, then sand and gravel, with ledge, to grade. The ledge was very irregular, varying from 1 to 19 feet in depth.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard (trench),	$12 50
Brickwork, American cement mortar, per cubic yard (tunnel),	13 85
Brickwork, Portland cement mortar, per cubic yard (trench),	14 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	15 65
Concrete, American cement mortar, per cubic yard (trench),	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	5 85
Concrete, Portland cement mortar, per cubic yard (trench),	6 75
Concrete, Portland cement mortar, per cubic yard (tunnel),	7 50

Diameters of underdrain laid and length of each size: —

6-inch,	263 feet.
8-inch,	590 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.73.

Length of masonry completed (trench), 802 feet.

Masonry begun in trench June 29, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $18.45.*

* To Sept. 30, 1896, no masonry has been built in tunnel on Section 17.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Tunnel.
Number of tunnel headings,	-	Two.
Date of starting,	May 14, 1896,	May 19, 1896.
Point of beginning,	In proposed street in Sumner estate, 75 feet south of southerly side of River Street.	In River Street, opposite easterly line of Sumner estate.
Point where work was in progress Sept. 30, 1896,	Near Neponset River, in estate of Caroline E. Mowry.	About 86 feet each way from shaft.
Length,	926 feet,	172 feet.
Ordinary progress per week,	50 feet,	14 feet.
Appliances used,	Stiff-leg derrick, engine and Brown Trench Machine.	Stiff-leg derrick and engine.
Size of gang ordinarily employed,	45 men,	15 men.

The ground-water was removed on the Sumner estate by a No. 5 pulsometer pump. At a well near the river, at the westerly line of the Field estate, a 4-inch centrifugal pump has been used, and at times a No. 5 pulsometer.

Foundation. — A 4-inch brick invert has been laid in a bed of American concrete, 6 inches in depth at the bottom and 6 to 8 inches in thickness at the springing line, for the whole section.

Surplus Material. — The surplus material from the excavations has been used in filling land adjacent to the line of the sewer.

Section 18 (Neponset Valley System), Hyde Park.

Location. — From near the junction of Metropolitan Avenue and Pierce Street, Hyde Park, south-westerly through private and railroad lands, through Station Street to a point in Walnut Street about 400 feet south-west of Fairmount Avenue.

Diameter and length of sewer: —

4 feet 3 inches by 4 feet 4 inches, ... 2,720 feet.

Contractors. — Troy Public Works Company of Troy, New York.

Contractors' Superintendent. — The work was superintended by Mr. M. McDonough, a member of the above-named corporation.

Contractors' Principal Foremen. — John McKenzie, James J. Cook, John Tohey, Walter Ferguson, John Jefferson.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspectors: Caleb Kimball, J. E. Savage, A. C. Page.

Transitmen: Principal (in charge of lines and grades) — S. G. Packard.
Principal (in charge of records) — T. T. Cass, J. L. Lee, Jr.
Assistant — B. A. Loveland, H. L. Morrow, Eugene Russ, L. D Hatch, Harry Kincaid.

* The above-named State assistants have been employed for part of the time only on Section 18.

Trench and Tunnel.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	2,630.00
Length of tunnel excavated to bottom of underdrain (feet),	48.00
Average depth of trench excavation to bottom of underdrain (feet),	16.50
Greatest depth of trench excavation to bottom of underdrain (feet),	24.00
Average width, top of trench (feet),	7.70
Average width, bottom of trench (feet),	6.70
Average depth from surface of ground to bottom of tunnel underdrain (feet),	23.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	23.00
Average width of tunnel excavation (feet),	8.20
Volume of trench excavation per linear foot (cubic yards),	4.80
Volume of tunnel excavation per linear foot (cubic yards),	2.50

Approximate cost per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $6.40.

Character of Excavation. — At the beginning of the section the formation consisted of 2 feet peat, then sand, gravel and boulders to grade. Ledge was encountered in the bottom about 20 feet from the beginning. Four hundred and fifty feet from the beginning, 1 foot sand, 2 feet gravel, 1 foot peat, 3 feet gravel, ledge to grade. The ledge ran out near the foot of West Street. From West Street for the next 600 feet, 2 feet peat, then sand, gravel and clay to grade; next 150 feet, 2 feet peat, 2 feet clay, fine wet sand to grade; at foot of Walter Street, 2 feet peat, 3 feet sand and gravel, fine wet sand to grade; opposite New England Railroad station, 8 inches gravel, 3 feet sand, 5 feet loamy gravel, 2 feet clay, 1 foot peat, yellow sandy clay to grade; Station Street, 200 feet south of Fairmount Avenue, 1 foot surfacing, 8 feet filling (sand and gravel), 3 feet peat, 6 feet sand and clay, running sand below.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 50
Brickwork, Portland cement mortar, per cubic yard,	14 50
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size: —

6-inch,	500 feet.
8-inch,	1,140 "
10-inch,	874 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $7.75.

Length of masonry completed (trench), 2,456 feet.

Masonry was begun in trench May 22, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $14.65.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.	Opening No. 4.
Character of opening,	Open cut,	Open cut,	Open cut,	Open cut and tunnel.
Number of tunnel headings,	– –	– –	– –	One.
Date of starting,	May 11, 1896,	May 11, 1896,	May 25, 1896,	Aug. 31, 1896.
Point of beginning,	At the beginning of the section near junction of Metropolitan Avenue and Pierce Street.	At foot of West Street,	About 600 feet north of New England Railroad station.	At the end of the section.
Point of ending, or where work was in progress Sept. 30, 1896,	At foot of West Street,	About 600 feet north of New England Railroad station.	At easterly side of New England Railroad tracks, 200 feet south of Fairmount Avenue.	93 feet back from end of section.
Date of finishing,	Aug. 3, 1896,	Aug. 26, 1896,	In progress Sept. 30, 1896,	In progress Sept. 30, 1896.
Length,	500 feet,	924 feet,	1,156 feet,	93 feet.
Ordinary progress per week,	40 feet,	70 feet,	90 feet,	25 feet.
Appliances used,	Hand labor,	Hand labor,	Carson Trench Machine,	Derrick and wheelbarrows.
Size of gang ordinarily employed,	20 men,	25 men,	30 men,	10 men.

The ground-water was taken care of by a 4-inch centrifugal pump near the beginning of the section, a 6-inch centrifugal pump at the foot of West Street and a 6-inch centrifugal pump near the beginning of Opening No. 3. The 4-inch pump and the first-mentioned 6-inch pump were afterwards used at points about 900 feet north of the New England Railroad station. As there was very little water at the beginning of the section, no measurements were taken. Estimated maximum rate of pumping per 24 hours, when the three pumps were working together, 1,000,000 gallons.

Foundation. — A very fine sand mixed with wet clay, which gave considerable trouble for a time, was encountered about 1,000 feet north of the New England Railroad station, and extended for a length of about 200 feet.

For a length of 260 feet, between the New England Railroad station and the coal sheds of S. B. Balkam & Co., nearly opposite Walter Street, it was found necessary to excavate to a depth of 6 to 8 inches below the bottom of the masonry and refill with gravel, the soil removed consisting of fine sand mixed with a small amount of clay.

The soil in the bottom of the trench has been generally sand and gravel, occasionally mixed with clay. An American concrete invert has been built through the greater portion of the section.

Difficulties. — Passing under the railroad, heavy stringers, 40 feet in length, were placed under each rail during the construction. All masonry within the railroad taking was of Portland cement, 6 inches of Portland concrete being placed over the arch in addition to the usual section.

Miscellaneous. — The sewer line at the crossing of the New England Railroad tracks, near the coal sheds of S. B. Balkam & Co., was moved southerly about 5 feet to get further from the bridge abutment. A slight change in the line was also made in Station Street, south of Fairmount Avenue, to avoid the pipes in that street.

Surplus Material. — Within the railroad yard surplus earth has been levelled over the sewer trench.

SECTION 19, HYDE PARK. VIEW IN WALNUT ST., JULY 30, 1896.

Section 19 (Neponset Valley System), Hyde Park.

Location. — From a point in Walnut Street, Hyde Park, about 400 feet south-west of Fairmount Avenue, extending south-westerly through Walnut Street and private lands, under New York, New Haven & Hartford Railroad, to Business Street and to a point in Business Street about 625 feet south-west of Barry Place.

Diameters of sewers and length of each size: —

4 feet 3 inches by 4 feet 4 inches,	1,287 feet
4 feet by 4 feet 1 inch,	1,355 "

Contractors. — George S. Good & Co. of Lock Haven, Pa.
Contractors' Superintendent. — F. C. Hitchcock.
Contractors' Principal Foreman. — Thomas Ferguson.

*State Assistants.**

Assistant Engineer: Seth Peterson.
Inspectors: A. C. Page, John Craib, J. E. Savage.
Transitmen: Principal (in charge of lines and grades) — S. G. Packard.
Principal (in charge of records) — T. T. Cass, J. L. Lee, Jr.
Assistant — H. L. Morrow, B. A. Loveland, Eugene Russ, Harry Kincaid.

Trench.

	4 Feet 3 Inches by 4 Feet 4 Inches Sewer.	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet),	1,050.00	89.00
Average depth of trench excavation to bottom of underdrain (feet),	19.30	16.50
Greatest depth of trench excavation to bottom of underdrain (feet),	25.00	17.00
Average width, top of trench (feet),	8.50	6.30
Average width, bottom of trench (feet),	6.00	6.30
Volume of trench excavation per linear foot (cubic yards),	5.00	4.00
Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896),	$4 90	$3 60

Character of Excavation. — Beginning of section, 1 foot street surfacing, sand, gravel and clay to a depth of about 18 feet; then mixture of clay and sand to grade. At Bridge Street, 1 foot surfacing, 4 feet gravel and sand, ledge to grade. Opposite corner Bleakie's Mill, 1 foot loam, 6 feet loam and gravel, 5 feet hard clay and gravel, hard pan below. Barry Place, 1 foot surfacing, 6 feet gravel, 3 feet fine sand, sand and gravel below.

* The above-named State assistants have been employed for part of the time only on Section 19.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 00
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 50

Diameters of underdrain laid and length of each size: —

6-inch,	212 feet.
8-inch,	813 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.90.

Length of masonry completed, 971 feet.

Masonry was begun in trench June 12, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $10.35.

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Open cut,	Open cut.
Date of starting,	May 18, 1896,	Sept. 16, 1896.
Point of beginning,	Beginning of section,	Barry Place, just west of New York, New Haven & Hartford Railroad.
Point where work was in progress Sept. 30, 1896,	In Bleakie's Mill yard, 150 feet ahead of Walnut Place.	In Barry Place, 100 feet from railroad tracks.
Length,	1,050 feet,	89 feet.
Ordinary progress per week,	60 feet,	30 feet.
Appliances used,	Carson Trench Machine,	Steam derrick.
Size of gang ordinarily employed,	30 men,	15 men.

The ground-water was taken care of at the beginning of the section by a 4-inch pulsometer; at the railroad tracks a 2-inch pump was used. At the beginning of the section the maximum rate of pumping in 24 hours was 35,000 gallons.

Foundation. — The bottom of the trench has been shaped to fit the invert of the sewer for several short lengths near the beginning of the section, making a total length of about 182 feet, in a formation of clay with gravel.

It was found necessary to excavate 4 inches below the bottom of the masonry for several short lengths on Walnut Street, aggregating 128 feet, and to refill with gravel. The earth removed was soft clay and sand.

At all points other than described above, the formation has con-

sisted of a mixture of clay and sand and about 268 feet of rock. This clay and sand was shaped as nearly as possible to fit the invert of the sewer, the uneven places being then filled with concrete.

Accident. — On Aug. 22, 1896, Thomas Murray, employed as water-boy, fell into the trench and broke his arm. He has recovered and is employed on the work again.

Miscellaneous. — From Barry Street to the end of the section the line has been moved easterly, in order to avoid pipes and to give additional room in the street for teams.

Surplus Material. — The surplus material has been used in filling low lands adjacent to the line of the sewer.

Section 20 (Neponset Valley System), Hyde Park.

Location. — From a point in Business Street, Hyde Park, about 625 feet south-west of Barry Street, extending south-westerly through Business and West River streets to a point about 25 feet east of Atherton Street.

Diameter and length of sewer: —

4 feet by 4 feet 1 inch, ... 3,228 feet.

Contractors. — George S. Good & Co. of Lock Haven, Pa.
Contractors' Superintendent. — F. C. Hitchcock.
Contractors' Principal Foreman. — H. H. De Grofft.

*State Assistants.**

Assistant Engineer: Seth Peterson.
Inspector: Geo. A. Chase.
Transitmen: Principal (in charge of lines and grades) — S. G. Packard.
Principal (in charge of records) — T. T. Cass, J. L. Lee, Jr.
Assistant — B. A. Loveland, H. L. Morrow, Eugene Russ, Harry Kincaid.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	1,645.00
Average depth of trench excavation to bottom of underdrain (feet), .	15.80
Greatest depth of trench excavation to bottom of underdrain (feet), .	19.30
Average width, top of trench (feet), ...	7.30
Average width, bottom of trench (feet), ...	6.60
Volume of trench excavation per linear foot (cubic yards), . .	4.50

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $3.70.

Character of Excavation. — At the beginning of the opening, 250 feet from beginning of section, 8 inches street surfacing, 8 feet sand and gravel, then sand and gravel with considerable clay to grade. At a point 100 feet from Business Street on River Street, 1 foot surfacing, 7 feet sand and gravel, fine sand below. At Ellis Street, 1 foot surfacing, 8 feet sand and gravel, then sand and clay to grade. Two hundred feet south of Church Street, 1 foot surfacing, 6 feet gravel, 1 foot sand and clay, then hard pan to grade.

* The above-named State assistants, except Mr. George A. Chase, have been employed for part of the time only on Section 20.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 00
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	6 00
Concrete, Portland cement mortar, per cubic yard,	7 50

Diameters of underdrain laid and length of each size: —

6-inch,	374 feet.
10-inch,	1,195 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.95.

Length of masonry completed, 1,511 feet.

Masonry was begun in trench June 19, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $9.95.

Excavation.

Character of opening,	Open cut.
Date of starting,	May 22, 1896.
Point of beginning,	250 feet from the beginning of the section.
Point where work was in progress Sept. 30, 1896,	200 feet south-west of Church Street.
Length,	1,645 feet.
Ordinary progress per week,	100 feet.
Appliances used,	Carson Trench Machine.
Size of gang ordinarily employed,	37 men.

The ground-water was removed by two 6-inch centrifugal pumps, one near the beginning of the section, at the corner of Glenwood Avenue and Business Street, and another on River Street, between Ellis and Church streets. The two pumps were in operation together for a few days only. The estimated maximum rate of pumping was 750,000 gallons in 24 hours.

Foundation. — A fine sand heavily charged with water was encountered from about opposite the Boston Blower Company's factory to the corner of River Street. This caused some delay in sinking a well at the corner of Glenwood Avenue. It was found necessary to excavate to a depth of 4 to 6 inches below grade and refill with gravel from a point 200 feet north-east of Glenwood Avenue to River Street, and in River Street for 170 feet between Business and Ellis streets, the earth removed being fine, wet sand.

For the whole section a concrete invert has been built.

Miscellaneous. — To avoid pipes and give more room for traffic, the sewer line has been moved from that shown on contract maps to westerly side of River Street.

Surplus Material. — The surplus material has been used for filling low land adjacent to the line of the sewer.

Section 21 (Neponset Valley System), Hyde Park and Dedham.

Location. — From a point in River Street, Hyde Park, about 25 feet east of Atherton Street, extending westerly through public and private lands along the northerly bank of Mother Brook to a point in Dedham about 1,000 feet west of the town line between Hyde Park and Dedham.

Diameter and length of sewer: —

4 feet by 4 feet 1 inch, ... 3,600 feet.

Contractors. — Mathers & Sullivan of Washington, D. C. The work was superintended by members of this firm.

Contractors' Principal Foreman. — Richard Morrisey.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspector: Chris Rasmussen.

Transitmen: Principal (in charge of lines and grades) — J. L. Brown.
Principal (in charge of records) — Geo. F. Chase.
Assistant — A. B. Cleaveland, F. W. Crispin, L. D. Hatch, H. E. Tatro.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	1,979.00
Average depth of trench excavation to bottom of underdrain (feet), .	12.00
Greatest depth of trench excavation to bottom of underdrain (feet), .	18.50
Average width, top of trench (feet), ...	6 70
Average width, bottom of trench (feet), ...	6.50
Volume of trench excavation per linear foot (cubic yards), . . .	2.90

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $3.55.

Character of Excavation. — From the beginning of the work for a distance of about 300 feet, 1½ feet loam, 2 feet sand and gravel, fine, wet sand below; for the next 1,100 feet, 1 foot loam, sand and gravel below; for the next 300 feet, ledge starts from about water line and runs to within a foot of surface, then drops back to grade; sand and gravel above ledge; beyond ledge, about 1 foot of loam, fine sand to grade.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard, ...	$10 35
Brickwork, Portland cement mortar, per cubic yard, ...	11 50
Concrete, American cement mortar, per cubic yard, ...	5 75
Concrete, Portland cement mortar, per cubic yard, ...	6 75

Diameters of underdrain laid and length of each size: —

8-inch, ...	30 feet.
10-inch, ...	1,740 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.40.

* The above-named State assistants, except Mr. Chris Rasmussen, have been employed for a part of the time only on Section 21.

Length of masonry completed (trench), ... 1,480 feet.

Masonry begun in trench July 27, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $9.65.

Excavation.

Character of opening, ...	Open cut.
Date of starting, ...	July 7, 1896.
Point of beginning, ...	About 150 feet from beginning of section.
Point where work was in progress Sept. 30, 1896,	About the middle of Fairview Cemetery.
Length, ...	1,979 feet.
Ordinary progress per week, ...	200 feet.
Appliances used, ...	Hand labor.
Size of gang ordinarily employed, . . .	85 men.

The ground-water was removed by a 6-inch centrifugal pump, which was located near the beginning of the section. A 6-inch Worthington pump was also used in the trench for a short time. The estimated maximum rate of pumping in 24 hours was 1,000,000 gallons.

Foundation. — A fine, wet sand was encountered for the first 300 feet of the section. This sand was removed to a depth of 8 inches below the masonry and replaced with gravel. At several other points in similar excavation 4 to 8 inches have been excavated below grade and replaced with gravel. On all other portions of the section the excavation at the bottom of the trench has consisted of sand and gravel.

A concrete invert has been used throughout the section.

Difficulties. — Some trouble occurred in sinking one of the pump-wells, due to fine sand; no special difficulty has been encountered on this section.

Surplus Material. — Considerable gravel from the excavation has been screened and used in concrete. Much of the surplus material has been spread within the lines of taking.

Section 22 (Neponset Valley System), Dedham.

Location. — From a point in Dedham about 1,000 feet west of the town line between Dedham and Hyde Park, extending in a north-westerly direction along the bank of Mother Brook, to a point about 550 feet north-west of Mill Lane.

Diameter and length of sewer: —

4 feet by 4 feet 1 inch, ... 2,400 feet.

Contractors. — Mathers & Sullivan of Washington, D. C. The work was superintended by members of this firm.

Contractors' Principal Foremen. — C. Broughton, D. A. Walker.

*State Assistants.**

Assistant Engineer: Seth Peterson.
Inspector: H. M. Woodward.
Transitmen: Principal (in charge of lines and grades) — J. L. Brown.
Principal (in charge of records) — Geo. F. Chase.
Assistant — L. D. Hatch, A. B. Cleaveland, F. W. Crispin, H. E. Tatro.

Trench.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of trench excavated to bottom of underdrain (feet),	920.00
Average depth of trench excavation to bottom of underdrain (feet),	16.00
Greatest depth of trench excavation to bottom of underdrain (feet),	24.00
Average width, top of trench (feet),	10.60
Average width, bottom of trench (feet),	6.50
Volume of trench excavation per linear foot (cubic yards),	5 00

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $10.

Character of Excavation. — From a point about 80 feet east of the Norfolk Mills dam, for a distance of about 155 feet, 1 foot loam, then sand, gravel and boulders to grade. The remainder of the excavation was through a similar formation with ledge in the bottom, running from water line of sewer to 15 feet above.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$10 35
Brickwork, Portland cement mortar, per cubic yard,	11 50
Concrete, American cement mortar, per cubic yard,	5 75
Concrete, Portland cement mortar, per cubic yard,	6 75

Diameters of underdrain laid and length of each size: —

6-inch,	268 feet.
8-inch,	178 "
4-inch,	80 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.85.

Length of masonry completed (trench), ... 492 feet.

Masonry was begun in trench Aug. 6, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $16.25.

Excavation.

Character of opening,	Open cut.
Date of starting,	July 13, 1896.
Point of beginning,	At Norfolk Mills dam.
Point where work was in progress Sept. 30, 1896,	400 feet west of Norfolk Mills dam and 500 feet east of same.
Length,	920 feet.
Ordinary progress per week,	90 feet.
Appliances used,	Rock removed from excavation by derrick; other material thrown out by hand.
Size of gang ordinarily employed,	90 men.

* The above named State assistants have been employed for part of the time only on Section 22.

The ground-water has been removed by two 2-inch Worthington pumps and a 6-inch Worthington pump. Maximum pumpage, 400,000 gallons in 24 hours.

Foundation. — None of the excavation has been shaped to fit the invert of the sewer. For 200 feet east of Norfolk Mills dam the excavation has been in sand and gravel mixed with clay. The bottom of the excavation for the remainder of the section has been of rock.

A concrete invert has been used throughout the section.

Difficulties. — Passing the Norfolk Mills dam, a concrete cut-off wall was carried up to the core-wall of the dam, and, for 10 feet on either side, the trench has been filled with Portland concrete to the crown of the sewer arch. To check the flow of water along the trench, concrete cut-off walls were built 30 feet either side of the dam.

Miscellaneous. — The sewer line was slightly changed above the dam to avoid valuable trees.

Section 23 (Neponset Valley System), Dedham.

Location. — From a point on the northerly bank of Mother Brook, 550 feet northwest of Mill Lane, extending north-westerly through public and private lands along Mother Brook to a point in Colburn Street about 40 feet south-easterly of Maverick Street.

Diameter and length of sewer: —

4 feet by 4 feet 1 inch, ... 2,600 feet.

Contractors. — Haskin & Murphy of Charlestown, Mass.

Contractors' Superintendent. — Thomas H. Murphy, a member of the above-mentioned firm.

Contractors' Principal Foremen. — Martin McLauthlin, Henry Burke.

*State Assistants.**

Assistant Engineer: Seth Peterson.

Inspector: Geo. F. Greenlaw.

Transitmen: Principal (in charge of lines and grades) — J. L. Brown.
Principal (in charge of records) — Geo. F. Chase.
Assistant — H. E. Tatro, L. D. Hatch, A.B. Cleaveland, F.W. Crispin.

Tunnel.

	4 Feet by 4 Feet 1 Inch Sewer.
Length of tunnel excavated to bottom of underdrain (feet), . .	676.00
Average depth from surface of ground to bottom of tunnel underdrain (feet), ...	24.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet), ...	28.50
Average width of tunnel excavation (feet), ...	5.80
Volume of tunnel excavation per linear foot (cubic yards), . . .	1.60

Approximate cost of tunnel excavation per linear foot, $10.†

Character of Excavation. — All rock (tunnel).

* The above-named State assistants have been employed for part of the time only on Section 23.

† Contractors' bid. No masonry or underdrain has been laid to date.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard (trench),	$12 00
Brickwork, American cement mortar, per cubic yard (tunnel),	14 00
Brickwork, Portland cement mortar, per cubic yard (trench),	13 00
Brickwork, Portland cement mortar, per cubic yard (tunnel),	15 00
Concrete, American cement mortar, per cubic yard (trench),	5 00
Concrete, American cement mortar, per cubic yard (tunnel),	6 00
Concrete, Portland cement mortar, per cubic yard (trench),	7 50
Concrete, Portland cement mortar, per cubic yard (tunnel),	8 50

Excavation.

	Opening No. 1.	Opening No. 2.
Character of opening,	Tunnel.	Tunnel.
Number of tunnel headings,	Two.	Two.
Date of starting,	July 20, 1896.	July 13, 1896.
Point of beginning,	About 175 feet from corner of Maverick and Colburn streets.	About 400 feet from corner of Maverick and Colburn streets.
Point where work was in progress Sept. 30, 1896,	134 feet toward Maverick Street from shaft; 150 feet north of shaft.	168 feet from shaft toward Maverick Street and 224 feet in opposite direction.
Length,	284 feet.	392 feet.
Ordinary progress per week,	30 feet.	40 feet.
Appliances used,	Drills run by compressed air; elevators at shaft; wheelbarrows.	Same appliances as in Opening No. 1.
Size of gang ordinarily employed,	21 men.	17 men.

The ground-water has been removed by a 2-inch steam pump at each shaft. The estimated maximum pumpage was 5,000 gallons per 24 hours.

Accident. — Henry Ryder, a laborer on the work, lost the sight of one eye, it having been struck by a flying chip of rock.

Surplus Material. — The surplus rock has been crushed; some of it has been sold and the remainder stored for use in the concrete masonry for the tunnel.

Section 24 (Neponset Valley System), Dedham.

Location. — From a point in Colburn Street, about 40 feet south-east of Maverick Street, extending north-westerly through private land along the northerly bank of Mother Brook to Curve Street.

Diameters of sewers and length of each size: —

4 feet by 4 feet 1 inch,	80 feet.
3 feet 9 inches by 3 feet 10 inches,	2,390 "

Contractors. — Haskin & Murphy of Charlestown, Mass.

Contractors' Superintendent. — Thomas H. Murphy, a member of the above-mentioned firm.

Contractors' Principal Foremen. — Tunnel: Martin McLaughlin, Henry Burke; Open cut: John McLaughlin.

*State Assistants.**

Assistant Engineer: Seth Peterson.
Inspector: George F. Greenlaw.
Transitmen: Principal (in charge of lines and grades) — George S. Miller.
Principal (in charge of records) — Geo. F. Chase.
Assistant — J. T. P. Jones, R. W. Greenlaw, Eugene Russ.

Trench and Tunnel.

	3 Feet 9 Inches by 3 Feet 10 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet),	70.00
Length of tunnel excavated to bottom of underdrain (feet),	562.00
Average depth of trench excavation to bottom of underdrain (feet),	17.50
Greatest depth of trench excavation to bottom of underdrain (feet),	17.50
Average width, top of trench (feet),	6.70
Average width, bottom of trench (feet),	6.40
Average depth from surface of ground to bottom of tunnel underdrain (feet),	20.00
Greatest depth from surface of ground to bottom of tunnel underdrain (feet),	23.00
Average width of tunnel excavation (feet),	5 80
Volume of trench excavation per linear foot (cubic yards),	4.25
Volume of tunnel excavation per linear foot (cubic yards),	1.60

Approximate cost of excavation per linear foot, $15.40.

Character of Excavation. — Tunnel, all rock. Open cut, about 2 feet loam, 6 feet gravelly clay and boulders, ledge below.

Masonry.†

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 50
Brickwork, Portland cement mortar, per cubic yard,	14 00
Concrete, American cement mortar, per cubic yard,	5 50
Concrete, Portland cement mortar, per cubic yard,	6 90

* The above-named State assistants have been employed for a part of the time only on Section 24.

† No masonry or underdrain has been laid to date.

Excavation.

	Opening No. 1.	Opening No. 2.	Opening No. 3.
Character of opening,	Tunnel,	Tunnel,	Open cut.
Number of tunnel headings,	Two,	Two,	- - -
Date of starting,	July 13, 1896,	July 20, 1896,	Aug. 3, 1896.
Point of beginning,	About 200 feet west of corner of Maverick and Colburn streets.	About 600 feet west of corner of Colburn and Maverick streets.	About 1,250 feet west of corner of Colburn and Maverick streets.
Point where work was in progress Sept. 30, 1896,	125 feet toward Maverick Street, 132 feet opposite direction.	160 feet toward Maverick Street, 155 feet opposite direction.	About 100 feet toward Maverick Street.
Length,	287 feet,	315 feet,	70 feet.
Ordinary progress per week,	30 feet,	35 feet,	20 feet.
Appliances used,	Elevators and cars to take material out of tunnel; drills run by compressed air.	Same as in Opening No. 1,	Travelling derrick.
Size of gang ordinarily employed,	17 men,	17 men,	30 men.

The ground-water has been removed by a 2-inch steam pump at shaft No. 1, a No. 5 pulsometer pump at shaft No. 2, and a 6-inch centrifugal pump at the open cut. The maximum rate of pumping has been 10,000 gallons in 24 hours.

Surplus Material. — Much of the surplus rock has been levelled near the shafts and stored along the excavated trench; some has been crushed and sold or used in concrete masonry.

Section 25 (Neponset Valley System), Dedham.

Location. — From a point in Curve Street, about 430 feet east of Washington Street, extending north-westerly through public and private land to a point about 100 feet north-west of the Dedham Branch of the New York, New Haven & Hartford Railroad.

Diameter and length of sewer: —

3 feet 9 inches by 3 feet 10 inches, ... 2,670 feet.

Contractor. — E. W. Everson of Providence, R. I.
Contractor's Superintendent and Foreman. — Geo. W. Upper.

*State Assistants.**

Assistant Engineer: Seth Peterson.
Inspectors: Geo. F. Greenlaw, Charles Roesbeck.
Transitmen: Principal (in charge of lines and grades) — Geo. S. Miller.
Principal (in charge of records) — Geo. F. Chase.
Assistant — J. T. P. Jones, R. W. Greenlaw, Eugene Russ.

Trench.

	3 Feet 9 Inches by 3 Feet 10 Inches Sewer.
Length of trench excavated to bottom of underdrain (feet), . .	650.00
Average depth of trench excavation to bottom of underdrain (feet), .	22.50
Greatest depth of trench excavation to bottom of underdrain (feet), .	23.00
Average width, top of trench (feet), ...	8.00
Average width, bottom of trench (feet), ...	6 00
Volume of trench excavation per linear foot (cubic yards), . . .	6.00

Approximate cost of trench per linear foot, including sheeting left in, excavation and refilling below masonry, back-filling, etc., to date (Sept. 30, 1896), $7.30.

Character of Excavation. — At beginning of section, 8 inches gravel street surfacing, 2½ feet loam, gravel and sand below; 40 feet east of Washington Street, 8 inches surfacing, 2½ feet loam, sand and fine gravel to grade; 200 feet west of Washington Street, 8 inches surfacing, 2½ feet loam, gravel and sand to arch, fine, wet sand to grade.

* The above-named State assistants have been employed for a part of the time only on Section 25.

SECTION 25, DEDHAM. VIEW IN CURVE ST., JULY 30, 1896.

Masonry.

Contract prices: —

Brickwork, American cement mortar, per cubic yard,	$12 00
Brickwork, Portland cement mortar, per cubic yard,	13 50
Concrete, American cement mortar, per cubic yard,	5 00
Concrete, Portland cement mortar, per cubic yard,	7 00

Diameters of underdrain laid and length of each size: —

10-inch,	428 feet.
12-inch,	197 "

Approximate cost of masonry per linear foot of trench, including underdrain, tarred paper, etc., to date (Sept. 30, 1896), $5.30.

Length of masonry completed (trench), ... 560 feet.

Masonry was begun in trench Aug. 22, 1896, and is now in progress (Sept. 30, 1896).

Approximate cost of section per linear foot of excavation and masonry, including labor, material, inspection and miscellaneous items, to date (Sept. 30, 1896), $13.

Excavation.

Character of opening,	Open cut.
Date of starting,	July 27, 1896.
Point of beginning,	At beginning of section.
Point where work was in progress Sept. 30, 1896,	Curve Street, about 50 feet east of Centre Street.
Length,	650 feet.
Ordinary progress per week,	150 feet.
Appliances used,	Brown excavator.
Size of gang ordinarily employed,	50 men.

The ground-water has been removed by an 8-inch centrifugal pump near the beginning of the section. A pulsometer was also used at the end of the excavated trench. The maximum pumpage has been 1,200,000 gallons in 24 hours.

Foundation. — None of the bottom excavation has been shaped to fit the invert of the sewer. For a length of about 100 feet near Washington Street the trench has been excavated below masonry to a depth of 12 inches and refilled with gravel in a formation of fine, wet sand. The bottom excavation, except as above described, has been in sand, gravel and ledge.

An American concrete invert has been used throughout the section.

Miscellaneous. — The sewer line has been moved toward the south side of the street from the beginning of the section to Centre Street, to afford more room for travel during the construction of the sewer.

Surplus Material. — Surplus material has been used as filling on lands adjacent to the line of the sewer.

Cement Testing.

Approximately 12,000 barrels of cement have been tested during the year, 4,000 barrels of Portland and 8,000 barrels of American. Four thousand tests have been made.

The cement used has been of the best English and American brands. The cement has been tested for fineness, strength, setting qualities, and for checking and cracking.

Table of Progress.

The following table recapitulates to some extent the detailed information given in the foregoing pages and in reports of preceding years. The Charles River Valley sections are designated by letters and those of the North Metropolitan and Neponset Valley areas by numbers.

Where work on the same section has continued through two or more years some statistics and other statements contained in former reports have been repeated for convenience of reference. This is desirable, among other reasons, on account of the great scarcity of some of the earlier reports.

The foregoing detailed reports of sections are in general condensed from those of the various assistant engineers directly connected with the work.

TABLE OF SEWER WORK COMPLETED AND IN PROGRESS SEPT. 30, 1896.

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1896. Feet.	Date of Completion named in Contract.
O	Boston,	Built by city of Boston,	1,897	6′ 6″,	23	1,897	May, 1890
A	Boston,	H. C. Eyre,	3,701	5′ 6″,	20.3	3,701	Aug. 31, 1891
B	Boston and Brookline,	H. C. Eyre,	2,962	5′ 6″,	18.5	2,962	Feb. 28, 1891
C	Brighton,	National Construction Co.,	5,787	4′ 10″,	16.4	5,787	Aug. 31, 1891
D	Brighton,	National Construction Co.,	5,300	4′ 10″×5′ 3″,	17.2	5,300	July 31, 1891
E	Brighton,	Jones & Meehan,	8,027	4′ 6″×5′ 1″,	14.7	8,027	Nov. 30, 1891
F	Newton and Watertown,	Jones & Meehan,	7,675	4′ 2″×4′ 9″, 3′ 11″×4′ 5″,	10.4	7,675	Nov. 30, 1891
G	Newton,	Jones & Meehan,	2,800	3′ 11″×4′ 5″, 3′ 6″×4′,	19.1	2,800	Nov. 30, 1891
H	Newton,	Metropolitan Construction Co.,	4,497	3′ 6″×4′,	13.7	4,497	Nov. 30, 1891
1	Deer Island,	Day work,	1,931	6′ 3″,	14	1,931	–
2	Deer Island,	National Construction Co.,	2,120	Outfall sewer, 6′×6′ to 6′×10′, Main sewer, 9′,	17 28	2,120	Feb. 29, 1892
3	Deer Island,	R. A. Malone & Co.,	2,641	9′,	26	2,641	April 30, 1891
3½	Deer Island and Winthrop,	Day work,	430	Main sewers, 9′, 6′ 4″, Sand-catcher, 16′×16′, Siphon, 6′ 2″,	21 23 13	138 28 264	–
4	Winthrop,	Metropolitan Construction Co.,	5,710	9′,	22	5,710	June 30, 1891

TABLE OF SEWER WORK COMPLETED, ETC. — *Continued.*

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1896. Feet.	Date of Completion named in Contract.
5	Winthrop,	Metropolitan Construction Co.,	4,600	9′,	16	4,600	July 31, 1891
6	Winthrop,	Metropolitan Construction Co.,	4,113	9′,	18	4,113	May 31, 1891
7	Winthrop and East Boston,	Trumbull & Ryan,	848	Main sewer, 8′ 6″×9′ 2″, Sand-catcher, 16′×16′ 5″, and siphon approaches, Siphon (3 parallel lines), 5′,	6.5 11.4 13.6	848	June 1, 1893
8	Breed's Island,	Charles Linehan,	4,126	9′,	16.4	4,126	Aug. 31, 1891
9	East Boston and Chelsea,	Charles Linehan,	3,383	9′,	15.8	3,383	May 31, 1891
10	East Boston and Chelsea,	Day work,	709	Siphon, 5′ 8″, Sand-catcher, 15′ 5″×16′ 1″,	53* 23†	709	–
11	Chelsea,	Charles Linehan,	3,034	2′ 1″×2′ 10″,	17.0	3,034	Sept. 30, 1894
12	Chelsea,	Orin P. Roberts,	3,034	8′ 4″×9′,	27.0	3,034	April 30, 1893
14	Chelsea,	Metropolitan Construction Co.,	3,445	8′ 10″, 8′ 4″×9′, 8′ 2″×8′ 10″,	28.60* 37.0†	3,445	Dec. 30, 1893
15	Chelsea,	Christy McBride,	1,754	8′ 2″×8′ 10″,	23.2	1,754	May 31, 1892
16	Everett,	R. A. Malone & Son,	4,431	8′ 2″×8′ 10″, 5′ 10″×6′ 4″,	21.1 20.7	4,431	Nov. 30, 1892
17	Everett,	Christy McBride,	3,528	5′ 10″×6′ 4″, 4′ 8″×5′ 1″,	21.4	3,528	Sept. 30, 1892
17½	Everett,	Metropolitan Construction Co.,	1,627	4′ 8″×5′ 1″,	17.0	1,627	Sept. 30, 1892

19	Everett and Medford,	Day work,	496	Sand catcher, 10 × 11′ 3″,	13.0	267	–
				4′ 8″ × 5′ 1″, 3′ 6″,			
				3′ 6″, 4′ 8″ × 6′ 2″,			
				3′ 6″,	12.7	229	–
20	Medford,	John Sheehan,	9,170	Main line, 4′ 8″ × 5′ 1″, 4′ 5″ × 4′ 8″,	18.5	9,170	April 30, 1893
				Edgeworth branch, 2′,	13.3		
21	Medford,	National Construction Co.,	8,030	4′ 5″ × 4′ 8″, 4′ 3″ × 4′ 6″,	14.0	8,030	Feb. 28, 1893
21	Medford (Gravelly Brook culvert),	Sub-contractors: Wm. H. Lenox & Co., A. W. Bryne,	54	4′ 5″ × 4′ 8″,	12.8	54	–
21	Medford (Winthrop Street culvert),	Day work,	181	4′ 3″ × 4′ 6″,	6.5	181	–
22	West Medford,	Andrew W. Bryne,	6,033	3′ 4″ × 3′ 6″,	23.0*	5,347	June 30, 1893
					28.0†	686	
23	Everett,	R. A. Malone & Sons,	2,268	6′ × 6′ 8″,	25.3	2,268	June 30, 1892
24	Everett and Charlestown,	Metropolitan Construction Co.,	2,332	6′ × 6′ 8″,	25.0	2,332	Sept. 30, 1892
25	Charlestown,	Day work,	1,540	Main sewer, 6′ × 6′ 8″, 6′ × 7′ 1″,	23.1*	1,540	–
				Siphon, 5′,	44.0†		
25½	Charlestown,	Day work,	585	6′ 7″ × 7′ 5″, 6′ 5″ × 7′ 2″,	27.3	585	–
25½	Arlington Avenue connection,	Day work,	61	40″ × 49″,	–	61	–
26	Charlestown and Somerville,	Harry P. Nawn,	3,750	6′ 5″ × 7′ 2″,	34.3†	3,750	Nov. 30, 1893
				5′ 9″ × 6′ 6″,	23.5*		
					28.8†		
26‡ 27‡	Somerville,	Day work,	950	5′ 9″ × 6′ 6″,	35.0†	950	–
27	Somerville and Cambridge,	McGovern & Kitch, Metropolitan Construction Co., Day work,	4,326	5′ 9″ × 6′ 6″,	24.4*	4,326	Aug. 31, 1893
				5′ 2″ × 5′ 9″,	22.9*		
					25.5†		
28	Cambridge,	John L. Reardon & Co.,	6,503	4′ × 4′ 6″,	19.2*	*6,424	April 30, 1894
					23.0†	†79	

* Trench. † Tunnel. ‡ Part of.

TABLE OF SEWER WORK COMPLETED, ETC. — *Continued.*

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1896. Feet.	Date of Completion named in Contract.
29	Cambridge,	Lindsay & Cudmore,	5,157	4′×4′ 6″, 3′ 8″×4′ 2″, 3′ 6″×4 ,.	16.2 12.9 18.0	5,157	Nov. 30, 1893
30	Cambridge,	Jones & Meehan,	7,032	3′ 5″×3′ 8″, 2′ 10″×3′, 2′ 8″×2′ 10″, 2′ 3″×2′ 4″,	13.8 15.6 12.7	7,032	April 30, 1894
31	Charlestown,	Metropolitan Construction Co.,	4,509	2′ 5″×3′ 1″, 3′ 1″×3′ 8″, 2′ 7″×3′ 3″, 1′ 3″,	*27.4 †31.8 23.7 –	4,509 –	Nov. 30, 1894
32	Charlestown,	Metropolitan Construction Co.,	4,705	2′ 7″×3′ 3″, 2′ 5″×3′ 1″, 2′ 3″×3′, 2′ 1″×2′ 10″, 1′ 7″×2′ 4″,	29.5 19.0 16.8 –	869 2,214 678 944	Nov. 30, 1894
32	Charlestown Navy Yard,	Day work,	1,572	2′ 1″×2′ 10″, 1′ 10″×2′ 7″, 1′ 7 ×2′ 4″,	*19.2 †16.8 –	992 580 –	–
35	Charlestown, Somerville and Medford,	James Heath & Son,	8,370	3′ 4″×4′ 1″, 3′ 3″×3′ 11″, 2′ 11″×3′ 7″, 1′ 10″×2′ 3″,	*29.0 †29.0 21.7	*214 †3,872 *4,230 †54	Nov. 30, 1894
36	East Boston,	National Construction Co.,	237	1′ 3″ vitrified pipe,	18.5	237	Sept. 30, 1894
37	East Boston,	John Sheehan,	4,882	3′ 4″×3′ 9″, 3′×3′ 5″	30.0 *26.5 †31.0	*2,144 †2,738	June 30, 1894

37½	East Boston,	Day work,	276	3′ 5″×3′ 10″,	28.0†	276	–
38	East Boston,	James Heath & Son,	8,229	3′×3′ 5″, 2′, 1′ 6″, 1′ 3″, 1′,	24 21 20 18	8,229	Nov. 15, 1894
39	East Boston,	Metropolitan Construction Co.,	6,944	1′ 6″, 1′ 3″, 1′,	21 14.5	6,944	Oct. 30, 1894
40	Everett and Malden,	R. A. Malone & Sons,	6,252	3′ 9″×4′ 1″,	16.0	6,252	Aug. 31, 1892
41	Malden and Melrose,	Moulton & O'Mahoney,	9,793	2′ 1″×3′ 2″, 1′ 10″×2′ 9″, 1′ 8″×2′ 6″,	13.0	9,793	Sept. 29, 1893
41	Malden,	Day work,	1,014	2′ 1″×3′ 2″, 1′ 8″×2′ 6″,	10.0	1,014	–
42	Melrose and Stoneham,	David L. Clements,	3,050	1′ pipe,	11.4	3,050	Nov. 30, 1892
43	Somerville and Cambridge,	Metropolitan Construction Co.,	14,450	2′ 11″×3′ 6″, 2′ 5″×3′ 1″, 2′ 3″×2′ 11″, 1′ 11″×2′ 9″, 1′ 6″ pipe, 1′ 3″ pipe,	20.0* 26.0† 10.5* 16.0† 7.0 7.0	14,450	Oct. 31, 1893
43½	Medford and Somerville,	Metropolitan Construction Co.,	2,312	3′×3′ 7″, 2′ 11″×3′ 6″,	13.1	2,312	Aug. 31, 1893
43½	Siphon, Mystic River,	Day work,	150	6′×7′ sand-catcher, 2′ pipe siphon,	–	150	–
44	Winchester,	Jones & Meehan,	5,608	2′ 7″×2′ 11″, 2′ 3′ ×2′ 6″, 2′×2′ 5″,	13.6* 20.0†	*5,354 †254	Nov. 30, 1893
44½	West Medford and Winchester,	Weaving, Booth & Co.,	5,605	2′ 11″×3′ 3″, 2′ 9″×3′ 1″,	12.0	5,605	Mar. 31, 1894
44½	Siphon, Abbajona River,	Abandoned contract work,	80	6′×14′ sand-catcher, 1′ 8″ pipe siphon,	4.0	80	–
45	Winchester,	Everson & Liddle,	6,508	2′×2′ 5″, 1′ 10″×2′ 3″,	9.6	6,508	Sept. 30, 1893
46	Winchester, Woburn and Stoneham,	Charles Linehan,	5,757	1′ 10″×2′ 3″, 1′ 6″×2′, 1′ 3″ pipe,	10.0 8.7* 21.0†	5,757	Aug. 31, 1893
47	Winchester and Woburn,	Lindsey & Cudmore,	4,510	1′ 8″, 1′ 6″, 1′ 3″ pipe,	8.0	4,510	Aug. 31, 1894
48	Somerville, Arlington and Medford,	Day work,	1,587	Decatur Street, 18″ pipe, Jerome Street, 12″ pipe, Boston Avenue, 10″ pipe,	– – –	456 553 578	–

* Trench. † Tunnel.

TABLE OF SEWER WORK COMPLETED, ETC. — *Concluded.*

Section.	Locality.	Name of Contractor.	Total Length of Section. Feet.	Size of Sewer.	Average Depth of Trench, Bottom of Underdrain or Deeper Excavation. Feet.	Length of Sewer completed Sept. 30, 1896. Feet.	Date of Completion named in Contract.
12	Dorchester,	Day work,	986	3′×3′ 1″,	16.0* / 26.0†	573 / 60	-
13	Dorchester,	H. P. Nawn,	3,800	3′×3′ 1″,	11.8* / 18.6†	3,331 / -	Oct. 1, 1896
14	Dorchester,	H. P. Nawn,	1,928	3′×3′ 1″, / 2′ 6″×2′ 7″,	10.2 / 14.3	1,928	Oct. 1, 1896
15	Dorchester and Hyde Park,	H. P. Nawn,	2,470	2′ 6″×2′ 7″, / 4′ 6″×4′ 7″,	15.6 / 18.9	1,464 / 96	Dec. 1, 1896
16	Hyde Park,	H. P. Nawn,	2,374	4′ 6″×4′ 7″, / 4′ 3″×4′ 4″,	26.4* / 27.9† / 20.5*	371 / 96 / -	Dec. 1, 1896
17	Hyde Park,	Geo. R. Newman & Co,	1,768	4′ 3″×4′ 4″,	16.0* / 30.4†	802 / -	Jan. 1, 1897
18	Hyde Park,	Troy Public Works Co.,	2,720	4′ 3″×4′ 4″,	16.5* / 23.0†	2,456 / -	Jan. 1, 1897
19	Hyde Park,	Geo. S. Good & Co.,	2,642	4′ 3″×4′ 4″, / 4′×4′ 1″,	19.3 / 16.5	971	Jan. 1, 1897
20	Hyde Park,	Geo. S. Good & Co.,	3,228	4′×4′ 1″,	15.8	1,511	Feb. 1, 1897
21	Hyde Park and Dedham,	Mathers & Sullivan,	3,600	4′×4′ 1″,	12.0	1,480	April 1, 1897
22	Dedham,	Mathers & Sullivan,	2,400	4′×4′ 1″,	16.0	492	April 1, 1897
23	Dedham,	Haskin & Murphy,	2,600	4′×4′ 1″,	24.0	-	June 1, 1897
24	Dedham,	Haskin & Murphy,	2,470	4′×4′ 1″, / 3′ 9″×3′ 10″,	22.0† / 17.5* / 20.0†	- / - / -	June 1, 1897
25	Dedham,	E. W. Everson,	2,670	3′ 9″×3′ 10′,	22.5	560	April 1, 1897

* Trench. † Tunnel.

Office Assistants.

In addition to the assistant engineers and other assistants above referred to, the following office assistants have been employed for the whole and parts of the year: —

Assistant Engineers: —
Charles H. Swan,* special hydraulic studies and calculations.
Winslow Blanchard,* mechanical studies, maintenance and equipment of pumping stations.
Frank I. Capen, in charge of day-work construction and maintenance studies.
Francis L. Sellew, in charge of surveys and draughting.
Charles E. Hathaway, in charge of records.

Assistants. — Theodore Horton,† B. A. Clark, E. W. Brown,† day-work construction and maintenance studies.

Draughtsmen: —
William J. Watkins.
Frank A. Emery.
Arthur H. Pratt.
Harry C. Dove.
Richard J. McNulty.†

Stenographer. — Henry P. Fielding.

Clerk. — Burton W. Torrey.

Cement Tester. — Nelson A. Hallett.*

Messenger. — Madison C. Lewis.

MAINTENANCE.

The pumping plants at all the stations have been in operation during the year and have given most excellent results.

Early in the year the pumps were not run more than 4 hours per day. As the sewage from additional areas was received from time to time into the mains, this time was increased to 12 to 16 hours per day, to avoid closing the regulators of connected low areas. Since Sept. 1, 1896, the pumps have operated continuously for 24 hours at all the stations. This method has been found economical, convenient and otherwise better than an intermittent service. The greatest pumping for any single day during the year occurred on Sept. 10, 1896, during a continued heavy storm. The record for that day is as follows: —

	Gallons.
Deer Island pumping station,	35,610,000
East Boston pumping station,	32,400,000
Charlestown pumping station,	20,412,000
Alewife Brook pumping station,	3,434,000

The total pumpage and average lifts for the year appear in the following table: —

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* Engaged for a portion of his time only by the Metropolitan Sewerage Commission.
† For a portion of the year.

Table of Approximate Quantities and Lifts at Pumping Stations of North Metropolitan System.

MONTHS.	Deer Island Station.		East Boston Station.		Charlestown Station.		Alewife Brook Station.	
	Total Pumpage.	Average Lift.	Total Pumpage.	Average Lift.	Total Pumpage.	Average Lift.	Total Pumpage.	Average Lift.
1895-96.	Gallons.	Feet.	Gallons.	Feet.	Gallons.	Feet.	Gallons.	Feet.
October,	260,499,000	11.4	236,817,000	11.9	139,111,000	9.3	57,947,000	12.7
November,	372,416,000	10.1	338,560,000	14.2	140,555,000	7.4	70,944,000	11.7
December,	324,034,000	11.1	294,577,000	13.9	84,672,000	8.4	60,876,000	12.3
January,	311,652,000	11.9	283,320,000	13.0	84,719,000	8.3	44,500,000	12.7
February,*	–	–	–	–	–	–	–	–
March,*	371,986,000	11.9	338,169,000	13.7	98,280,000	6.9	58,893,000	12.6
April,†	393,184,000	12.3	357,440,000	14.2	128,213,000	7.1	64,550,000	13.2
May,†	234,729,000	11.9	213,390,000	13.3	27,722,000	7.8	40,466,000	13.3
June,	269,854,000	11.9	245,322,000	13.0	130,399,000	9.2	26,623,000	13.2
July,	345,151,000	11.0	313,774,000	13.2	203,826,000	8.9	32,718,000	12.8
August,	402,910,000	11.9	366,282,000	13.0	239,139,000	8.0	36,005,000	12.7
September,	602,694,000	10.7	547,904,000	14.6	349,920,000	8.0	48,814,000	12.7
Total number of gallons pumped from Oct. 1, 1895, to Sept. 30, 1896, inclusive, and average lifts for the year,	3,889,109,000	11.5	3,535,555,000	13.5	1,626,556,000	8.1	542,336,000	12.7

* From January 31 to March 9, inclusive, during the trials of the pumping plants at Deer Island and East Boston, the system was not operated.

† During the trials of the pumping plant at the Charlestown station, April 24 to May 24, inclusive, no sewage was pumped at that station.

It appears from the table that the amount pumped at East Boston is 90 per cent., at Charlestown 42 per cent. and at Alewife Brook 14 per cent. of the total yearly delivery at the outfall.

Thirty-six connections have now been made with the Metropolitan main in cities and towns in the Charles-river area. These provide an outlet for approximately 208.40 miles of local sewers. The population now using these local sewers is estimated at 50,540 persons. This area embraces about 42 square miles, of which 45 per cent. is sewered and connected with the Metropolitan System. It is estimated that 50 per cent. of the population resident upon the whole area is contributing sewage to the system.

The following table, compiled from returns made by the several cities and towns, gives additional data relating to uses made of the Metropolitan System within the Charles-river area to date : —

CHARLES RIVER VALLEY SYSTEM.

Table showing Cities and Towns delivering Sewage to This System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House-connection.*	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area Ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
Part of Boston (proper),	13.20	Separate and combined.	674	5.1	3,437	11,930	1.00	1.61	28.80	62.00
Boston (Brighton), .	27.10	Separate and combined.	1,561	5.1	7,961	15,590	2.90	4.27	51.20	68.00
Brookline, . . .	44.21	Combined, .	1,689	6.6	11,147	16,970	2.80	4.84	65.70	57.80
Newton, ...	66.80	Separate, .	2,531	5.2	13,161	28,271	8.92	13.60	46.60	65.60
Watertown, . . .	20.10	Separate, .	794	4.7	3,732	7,931	0.97	4.04	47.00	24.00
Waltham, . . .	37.03	Separate, .	2,135	5.2	11,102	21,311	2.17	13.63	52.20	15.90
	208.44	- -	9,384	- 5.4	50,540	102,003	18.76	41.99	49.50	44.70

* This is estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1895 extended to 1896.

Fifty-four connections have now been made with the North Metropolitan System in cities and towns within the area. These provide an outlet for approximately 253.70 miles of local sewers. The population now using these local sewers is estimated at 98,703 persons. This area embraces about 73 square miles, of which 22 per cent. is sewered and connected with the Metropolitan System. It is estimated that 26 per cent. of the population resident upon the whole area is contributing sewage to the system.

The following table, compiled from returns made by the several cities and towns, gives additional data relating to uses of the North Metropolitan System : —

NORTH METROPOLITAN SYSTEM.

Table showing Cities and Towns delivering Sewage to This System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

CITIES AND TOWNS.	Miles of Local Sewer connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served per Each House-connection.*	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Square Miles.	Square Miles.	Per Cent.	Per Cent.
Boston (Deer Island),	0.20	– –	–	–	1,000†	–	–	–	–	–
Winthrop,	17.90	Separate,	980	3.6	3,528	4,485	1.01	1.61	78.70	62.80
Boston (East Boston),	1.01	Separate and combined.	114	8.6	980	43,527	0.04	2.18	22.50	1.80
Everett,	9.10	Separate,	331	5.1	1,688	20,080	0.92	3.34	8.40	27.60
Malden,	32.00	Separate,	1,766	5.3	9,360	31,041	2.58	5.07	30.20	50.90
Melrose,	17.07	Separate,	535	4.2	2,247	12,655	1.56	3.73	17.80	41.90
Cambridge,	87.65	Separate and combined.	8,271	6.5	53,762	83,817	3.77	6.11	64.20	61.70
Somerville,	19.22	Separate and combined.	3,289	5.5	18,089	54,601	0.82	3.96	33.10	20.70
Medford,	35.12	Separate,	792	5.1	4,039	15,160	1.74	8.35	26.60	20.80
Winchester,	13.81	Separate,	164	5.3	869	6,403	0.99	5.95	13.50	16.70
Woburn,	10.58	Separate,	456‡	5.3	2,416	14,311	1.24	12.70	16.90	9.80
Arlington,	6.35	Separate,	33	5.6	185	6,692	1.04	5.20	27.70	20.00
Belmont,	3.64	Separate,	28§	5.6	540	2,992	0.47	4.66	18.10	10.00
‖ Boston (Charlestown),	–	– –	–	–	–	40,139	–	1.27	–	–
‖ Chelsea,	–	– –	–	–	–	31,972	–	2.24	–	–
‖ Stoneham,	–	– –	–	–	–	6,310	–	5.50	–	–
‖ Wakefield,	–	– –	–	–	–	641	–	0.95	–	–
	253.65	– –	16,759	5.9	98,703	374,826	16.18	72.82	26.30	22.20

* This is estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1895 extended to 1896.

† Estimated by Superintendent J. R. Gerrish of the Institution on Deer Island.

‡ Exclusive of Mystic Valley sewer and tanneries.

§ Including 3 connections with Massachusetts General Hospital, having an estimated population of 400.

‖ Charlestown, Chelsea, Stoneham and Wakefield not connected.

Careful measurements of losses of head at all the Metropolitan siphons have been made at intervals during the year. They indicate that no deposits of any consequence have thus far occurred in the siphons.

All the Metropolitan sewers are now satisfactorily clean and in a normal condition. Hand-cleaning and flushing have been required several times on the Mystic Valley branch, acquired from the city of Boston, and now receiving tannery sewage from Winchester and Woburn.

The outlet at Deer Island has operated satisfactorily during the year. A minute examination of the Deer Island bar and the adjacent shores has been made, and no deposits due to the discharge of sewage have been found. Under the most unfavorable conditions of wind and tide, the presence of sewage can be detected hardly more than 100 feet from the outlet.

I desire to thank you for your continued courtesy and kindness during the year, and to express an appreciation of the efficient service of all the employees in the engineering department.

Respectfully submitted,

WILLIAM M. BROWN, Jr.,
Chief Engineer and Superintendent.

APPENDIX.

TABLE A. — *Miscellaneous Bids upon the North Metropolitan System.*

NAMES OF BIDDERS.	RESIDENCE.	DEER ISLAND PUMPING STATION.		CHARLESTOWN PUMPING STATION.		
		COAL.[1]	COAL.[1]	COAL.[1]	INTERIOR FINISH.	COAL.[1]
		Bids opened Oct. 26, 1895.	Bids opened June 27, 1896.	Bids opened Dec. 7, 1895.	Bids opened Oct. 26, 1895.	Bids opened June 27, 1896.
C. A. Campbell & Co.,	Boston,	$3 62 [2]	$3 89 [2]	*$3 55 [2]	–	$3 89 [2]
Alden & Nevin,	Boston,	3 85 [2]	3 87 [2]	–	–	3 87 [2]
Curren & Burton,	Boston,	*3 45 [3]	–	3 55 [3]	–	3 64 [2]
Garfield & Proctor,	Boston,	3 95 [4] / 3 75 [5]	*3 49 [6]	–	–	*3 49 [6]
J. Robbins & Co.,	Boston,	–	4 60 [2]	4 20 [2]	–	4 35 [2]
J. Albert Walker & Co.,	Boston,	–	–	3 70 [2]	–	–
B. F. Wild & Co.,	Boston,	–	–	3 65 [2]	–	–
New Central Coal Company,	Maryland,	3 63 [2]	–	–	–	–
Mack & Moore,	Boston,	–	–	–	$2,250 00	–
Wm. Richmond & Co.,	Boston,	–	–	–	1,909 00	–
John S. Jacobs & Son,	Boston,	–	–	–	1,975 00	–
Hersee Bros.,	Boston,	–	–	–	5,800 00	–
William H. Keyes & Co.,	Boston,	–	–	–	*1,848 00	–
L. G. Burnham & Co.,	Boston,	–	3 69 [2]	–	–	3 69 [2]
John Morrison,	Boston,	–	3 59 [2]	–	–	3 59 [2]
E. B. Townsend,	Boston,	–	3 55 [2]	–	–	3 88 [2]
Philip H. Butler & Co.,	Boston,	–	–	–	–	–
Bowker, Torrey & Co.,	Boston,	–	–	–	–	–
Chas. E. Hall & Co.,	Boston,	–	–	–	–	–
Abberthaw Construction Company,	Boston,	–	–	–	–	–

[1] Bids in all cases based upon *long* ton.
[2] Cumberland.
[3] Pocahontas.
[4] Barton Mine.
[5] Bituminous.
[6] Borden Mine.
* Contract awarded.

TABLE A. — *Miscellaneous Bids upon the North Metropolitan System* — Concluded.

NAMES OF BIDDERS.	RESIDENCE.	CHARLESTOWN PUMPING STATION — Con.		EAST BOSTON PUMPING STATION.	ALEWIFE BROOK PUMPING STATION.
		MARBLE FLOORS.	GRANOLITHIC FLOORING.	COAL.[1]	GRANOLITHIC FLOORING.
		Bids opened Oct. 4, 1895.	Bids opened Oct. 12, 1895.	Bids opened June 27, 1896.	Bids opened Oct. 12, 1895.
C. A. Campbell & Co.,	Boston,	–	–	$3 89 [2]	–
Alden & Nevin,	Boston,	–	–	3 87 [2]	–
Curren & Burton,	Boston,	–	–	3 64 [2]	–
Garfield & Proctor,	Boston,	–	–	*3 49 [3]	–
J. Robbins & Co.,	Boston,	–	–	4 35 [2]	–
J. Albert Walker & Co.,	Boston,	–	–	–	–
B. F. Wild & Co.,	Boston,	–	–	–	–
New Central Coal Company,	Maryland,	–	–	–	–
Mack & Moore,	Boston,	–	–	–	–
Wm. Richmond & Co.,	Boston,	–	–	–	–
John S. Jacobs & Son,	Boston,	–	–	–	–
Hersee Bros.,	Boston,	–	–	–	–
William H. Keyes & Co.,	Boston,	–	–	–	–
L. G. Burnham & Co.,	Boston,	–	–	3 69 [2]	–
John Morrison,	Boston,	–	–	3 59 [2]	–
E. B. Townsend,	Boston,	–	–	3 88 [2]	–
Philip H. Butler & Co.,	Boston,	†$780 00	–	–	–
Bowker, Torrey & Co.,	Boston,	†859 00	–	–	–
Chas. E. Hall & Co.,	Boston,	†928 00	–	–	–
Abberthaw Construction Company,	Boston,	–	*$0 14 [4]	–	*$0 14 [4]

[1] Bids in all cases based upon *long* ton.
[2] Cumberland.
[3] Borden Mine.
[4] Per square foot.
* Contract awarded.
† Bids rejected.

TABLE B. — *Bids for Construction of Sections upon the Neponset Valley System.*

NAMES OF BIDDERS.	RESIDENCE.	BIDS OPENED MARCH 21, 1896.		BIDS OPENED MARCH 28, 1896.		BIDS OPENED APRIL 18, 1896.	
		Section 13, Dorchester.	Section 14, Dorchester.	Section 15, Dorchester and Hyde Park.	Section 16, Hyde Park.	Section 17, Hyde Park.	Section 18, Hyde Park.
A. W. Bryne Construction Co,	Boston, Mass.,	$48,597 00	$39,649 00	$43,754 00	$36,921 00	–	–
Edward W. Everson,	Boston, Mass.,	48,373 00	29,848 50	47,467 50	46,835 00	–	–
Jones & Meehan,	Jamaica Plain, Mass.,	42,947 50	33,790 00	44,613 00	46,869 00	$34,236 50	$38,880 00
Troy Public Works Co.,	Troy, N. Y.,	37,808 00	26,585 00	37,115 00	35,450 00	32,907 00	*33,820 00
Frank L. Allen,	Worcester, Mass.,	37,376 50	33,871 00	45,686 50	48,177 00	–	–
F. A. Snow,	Boston, Mass.,	36,090 00	25,280 00	43,953 25	42,788 75	33,086 60	34,433 00
J. P. O'Connell,	Dorchester, Mass.,	35,887 50	28,941 00	–	–	–	36,331 50
Quimby & Ferguson,	South Boston, Mass.,	34,668 55	23,861 00	37,755 65	34,172 60	33,318 95	43,232 20
H. A. Hanscom & Co.,	West Medford, Mass.,	34,584 50	27,074 25	52,149 50	39,828 00	–	–
H. P. Nawn,	Boston, Mass.,	*29,972 00	*21,814 80	*36,062 50	*33,231 00	–	–
Craib & Trumbull,	Winthrop, Mass.,	–	28,076 00	39,718 00	54,816 50	–	–
T. H. Bryne & Co.,	Melrose, Mass,	–	25,717 50	–	39,131 00	–	–
Geo. R. Newman & Co.,	Providence, R. I.,	–	–	36,793 75	33,247 65	*27,170 20	36,742 00
William T. Ross,	Waltham, Mass,	–	–	–	–	–	27,378 50
Aab & Co.,	Waltham, Mass.,	–	–	–	–	–	–
John H. McNight,	Pittsburg, Pa.,	–	–	–	–	–	–
Geo. S. Good & Co.,	Lock Haven, Pa.,	–	–	–	–	–	–
S. W. Frescoln,	Reading, Pa.,	–	–	–	–	–	–
Ezra A. Mathers,	Washington, D. C.,	–	–	–	–	–	–
Michael Sullivan,	Cincinnati, O.,	–	–	–	–	–	–
Richard A. Malone & Son,	Boston, Mass.,	–	–	–	–	–	–
Haskin & Murphy,	Charlestown, Mass.,	–	–	–	–	–	–

* Contract awarded.

TABLE B. — *Bids for Construction of Sections upon the Neponset Valley System* — Concluded.

NAMES OF BIDDERS.	RESIDENCE.	BIDS OPENED APRIL 25, 1866.		BIDS OPENED JUNE 13, 1896.		BIDS OPENED JUNE 27, 1896.		
		Section 19, Hyde Park.	Section 20, Hyde Park.	Section 21, Hyde Park and Dedham.	Section 22, Dedham.	Section 23, Dedham.	Section 24, Dedham.	Section 25, Dedham.
A. W. Bryne Construction Co.,	Boston, Mass.,	–	–	–	–	–	–	–
Edward W. Everson,	Boston, Mass.,	–	–	$45,580 00	$42,386 00	$41,901 00	$45,588 00	*$30,115 00
Jones & Meehan,	Jamaica Plain, Mass.,	$32,305 25	$38,872 60	–	–	–	–	–
Troy Public Works Co.,	Troy, N. Y.,	25,443 30	29,581 70	–	–	–	–	–
Frank L. Allen,	Worcester, Mass.,	–	–	–	–	–	–	–
F. A. Snow,	Boston, Mass.,	26,494 50	36,767 50	–	–	–	–	–
J. P. O'Connell,	Dorchester, Mass.,	27,639 90	37,757 05	42,882 50	39,322 00	56,531 00	60,958 00	31,580 00
Quimby & Ferguson,	South Boston, Mass.,	26,145 44	34,103 09	–	–	–	–	–
H. A. Hanscom & Co.,	West Medford, Mass.,	–	–	–	–	–	–	–
H. P. Nawn,	Boston, Mass.,	–	–	39,700 00	42,414 00	53,732 00	59,273 00	–
Craib & Trumbull,	Winthrop, Mass.,	26,698 00	–	–	37,482 00	–	47,030 00	36,190 00
T. H. Bryne & Co.,	Melrose, Mass.,	–	–	43,730 00	46,417 00	–	–	–
Geo. R. Newman & Co.,	Providence, R. I.,	26,613 90	29,761 69	47,196 50	52,702 00	–	–	–
William T. Ross,	Waltham, Mass.,	–	–	–	–	–	–	–
Aab & Co.,	Waltham, Mass.,	30,953 85	37,351 40	–	–	–	–	–
John H. McNight,	Pittsburg, Pa.,	28,449 70	–	–	–	–	–	–
Geo. S. Good & Co.,	Lock Haven, Pa.,	*24,814 35	*27,219 00	76,342 50	67,822 00	–	–	–
S. W. Frescoln,	Reading, Pa.,	–	34,637 30	–	41,671 00	47,603 25	55,267 50	–
Ezra A. Mathers,	Washington, D. C.,	–	–	*34,712 50	*33,800 90	–	–	–
Michael Sullivan,	Cincinnati, O.,	–	–	–	–	62,934 00	70,195 50	47,472 00
Richard A. Malone & Son,	Boston, Mass.,	–	–	–	–	45,357 50	37,613 00	29,043 00
Haskin & Murphy,	Charlestown, Mass.,	–	–	–	–	*34,556 00	*39,113 50	–

* Contract awarded.

TABLE C. — *Neponset Valley System.*

SECTIONS.	LOCATION.	Advertised for Bids.	Bids opened.	Number of Bids.	Highest.	Lowest.
Section 13, ...	Dorchester, Mass., . .	March 5, 1896,	March 21, 1896,	10	$48,597 00	$29,972 00
14, ...	Dorchester, Mass., . .	5, 1896,	21, 1896,	12	39,649 00	21,814 80
15, ...	Dorchester, Mass., . .	5, 1896,	28, 1896,	11	52,149 50	36,062 50
16, ...	Hyde Park, Mass., . .	5, 1896,	28, 1896,	12	54,816 50	33,231 00
17, ...	Hyde Park, Mass., . .	April 5, 1896,	April 18, 1896,	5	34,236 50	27,170 20
18, ...	Hyde Park, Mass., . .	5, 1896,	18, 1896,	7	43,232 20	27,378 50
19, ...	Hyde Park, Mass , . .	5, 1896,	25, 1896,	10	32,305 25	24,814 35
20, ...	Hyde Park, Mass., . .	5, 1896,	25, 1896,	9	38,872 60	27,219 00
21, ...	Hyde Park, Mass., . .	May 31, 1896,	June 13, 1896,	7	76,342 50	34,712 50
22, ...	Dedham, Mass., . .	31, 1896,	13, 1896,	9	67,822 00	33,800 90
23, ...	Dedham, Mass., . .	June 16, 1896,	27, 1896,	7	62,934 00	34,556 00
24, ...	Dedham, Mass., . .	16, 1896,	27, 1896,	8	70,195 50	37,613 00
25, ...	Dedham, Mass., . .	16, 1896,	27, 1896,	5	47,472 00	29,043 00
					$668,624 55	$397,387 75

TABLE C. — *Neponset Valley System* — Concluded.

SECTIONS.	LOCATION.	Contract awarded to —	Residence.	Amount Bid on Items for Comparison.	Work began.	To be completed.	Length of Section.
							Feet.
Section 13, .	Dorchester, Mass.,	H. P. Nawn, . . .	Boston, Mass., . .	$29,972 00	April 6, 1896,	Oct. 1, 1896,	3,800
14, .	Dorchester, Mass.,	H. P. Nawn, . . .	Boston, Mass., . .	21,814 80	6, 1896,	1, 1896,	1,927
15, .	Dorchester, Mass.,	H. P. Nawn, . . .	Boston, Mass., . .	36,062 50	6, 1896,	Dec. 1, 1896,	2,470
16, .	Hyde Park, Mass.,	H. P. Nawn, . . .	Boston, Mass., . .	33,231 00	6, 1896,	1, 1896,	2,370
17, .	Hyde Park, Mass.,	George R. Newman & Co.,	Providence, R. I., .	27,170 20	May 11, 1896,	Jan. 1, 1897,	1,766
18, .	Hyde Park, Mass.,	Troy Public Works Co , .	Troy, N. Y., . .	33,820 00	11, 1896,	1, 1897,	2,720
19, .	Hyde Park, Mass.,	George S. Good & Co., .	Lock Haven, Pa., .	24,814 35	18, 1896,	1, 1897,	2,642
20, .	Hyde Park, Mass.,	George S. Good & Co., .	Lock Haven, Pa , .	27,219 00	22, 1896,	Feb. 1, 1897,	3,228
21, .	Hyde Park, Mass.,	Ezra A. Mathers, . .	Washington, D. C., .	34,712 50	July 11, 1896,	April 1, 1897,	3,600
22, .	Dedham, Mass., .	Ezra A. Mathers, . .	Washington, D. C., .	33,800 90	20, 1896,	1, 1897,	2,400
23, .	Dedham, Mass., .	Haskin & Murphy, . .	Charlestown, Mass.,	34,556 00	11, 1896,	June 1, 1897,	2,600
24, .	Dedham, Mass., .	Haskin & Murphy, . .	Charlestown, Mass.,	39,113 50	11, 1896,	1, 1897,	2,470
25, .	Dedham, Mass., .	Edward W. Everson, .	Boston, Mass., . .	30,115 00	27, 1896,	April 1, 1897,	2,670
				$406,401 75			

TABLE D. — *Maintaining and Operating North Metropolitan System of Sewerage.*

		DR.			
1896.		Balance Sept. 30, 1895,			$68,045 26
Feb.	15,	To appropriation made by chapter 77, Acts of 1896,			91,500 00
					$159,545 26
1895.		CR.			
Oct.	31,	By pay rolls for month, general,	$1,383 91		
	31,	By supplies for month, general,	1,057 78		
	31,	By pay rolls for month, Deer Island station,	679 48		
	31,	By supplies for month, Deer Island station,	344 33		
	31,	By pay rolls for month, East Boston station,	274 91		
	31,	By supplies for month, East Boston station,	277 85		
	31,	By pay rolls for month, Charlestown station,	336 89		
	31,	By supplies for month, Charlestown station,	206 70		
	31,	By pay rolls for month, Alewife Brook station,	254 52		
	31,	By supplies for month, Alewife Brook station,	171 97		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	750 00		
				$5,738 34	
Nov.	30,	By pay rolls for month, general,	$1,192 23		
	30,	By supplies for month, general,	917 40		
	30,	By pay rolls for month, Deer Island station,	699 94		
	30,	By supplies for month, Deer Island station,	293 06		
	30,	By pay rolls for month, East Boston station,	287 95		
	30,	By supplies for month, East Boston station,	284 95		
	30,	By pay rolls for month, Charlestown station,	361 60		
	30,	By supplies for month, Charlestown station,	347 12		
	30,	By pay rolls for month, Alewife Brook station,	312 20		

	30,	By supplies for month, Alewife Brook station,	142 06		
	30,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	500 00		
				5,338 51	
Dec.	31,	By pay rolls for month, general,	$1,711 45		
	31,	By supplies for month, general,	851 46		
	31,	By pay rolls for month, Deer Island station,	691 52		
	31,	By supplies for month, Deer Island station,	903 36		
	31,	By pay rolls for month, East Boston station,	372 01		
	31,	By supplies for month, East Boston station,	1,524 48		
	31,	By pay rolls for month, Charlestown station,	366 55		
	31,	By supplies for month, Charlestown station,	552 30		
	31,	By pay rolls for month, Alewife Brook station,	260 10		
	31,	By supplies for month, Alewife Brook station,	574 01		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	500 00		
				8,307 24	
1896.					
Jan.	31,	By pay rolls for month, general,	$2,466 68		
	31,	By supplies for month, general,	1,687 21		
	31,	By pay rolls for month, Deer Island station,	642 52		
	31,	By supplies for month, Deer Island station,	1,776 91		
	31,	By pay rolls for month, East Boston station,	367 06		
	31,	By supplies for month, East Boston station,	1,508 80		
	31,	By pay rolls for month, Charlestown station,	361 60		
	31,	By supplies for month, Charlestown station,	1,074 02		
	31,	By pay rolls for month, Alewife Brook station,	194 64		
	31,	By supplies for month, Alewife Brook station,	593 14		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	1,016 66		
				11,689 24	
		Amounts carried forward,	. . .	$31,073 33	$159,545 26

TABLE D — *Continued.*

1896.		*Amounts brought forward,*		$31,073 33	$159,545 26
Feb.	29,	By pay rolls for month, general,	$3,377 37		
	29,	By supplies for month, general,	1,296 42		
	29,	By pay rolls for month, Deer Island station,	841 67		
	29,	By supplies for month, Deer Island station,	1,073 36		
	29,	By pay rolls for month, East Boston station,	635 44		
	29,	By supplies for month, East Boston station,	1,707 59		
	29,	By pay rolls for month, Charlestown station,	555 46		
	29,	By supplies for month, Charlestown station,	867 85		
	29,	By pay rolls for month, Alewife Brook station,	293 74		
	29,	By supplies for month, Alewife Brook station,	663 30		
	29,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	1,016 66		
				12,328 86	
March	31,	By pay rolls for month, general,	$629 11		
	31,	By supplies for month, general,	654 63		
	31,	By pay rolls for month, Deer Island station,	542 27		
	31,	By supplies for month, Deer Island station,	79 14		
	31,	By pay rolls for month, East Boston station,	424 96		
	31,	By supplies for month, East Boston station,	296 24		
	31,	By pay rolls for month, Charlestown station,	351 71		
	31,	By supplies for month, Charlestown station,	278 05		
	31,	By pay rolls for month, Alewife Brook station,	189 24		
	31,	By supplies for month, Alewife Brook station,	210 27		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	1,016 68		
				4,672 30	

April	30,	By pay rolls for month, general,	$992 88		
	30,	By supplies for month, general,	136 55		
	30,	By pay rolls for month, Deer Island station,	549 12		
	30,	By supplies for month, Deer Island station,	-		
	30,	By pay rolls for month, East Boston station,	527 82		
	30,	By supplies for month, East Boston station,	13 79		
	30,	By pay rolls for month, Charlestown station,	384 68		
	30,	By supplies for month, Charlestown station,	4 65		
	30,	By pay rolls for month, Alewife Brook station,	189 24		
	30,	By supplies for month, Alewife Brook station,	-		
	30,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	750 00		
				3,548 73	
May	31,	By pay rolls for month, general,	$1,266 58		
	31,	By supplies for month, general,	748 32		
	31,	By pay rolls for month, Deer Island station,	516 20		
	31,	By supplies for month, Deer Island station,	624 10		
	31,	By pay rolls for month, East Boston station,	470 93		
	31,	By supplies for month, East Boston station,	454 36		
	31,	By pay rolls for month, Charlestown station,	180 79		
	31,	By supplies for month, Charlestown station,	555 54		
	31,	By pay rolls for month, Alewife Brook station,	443 67		
	31,	By supplies for month, Alewife Brook station,	264 52		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	500 00		
				6,025 01	
		Amounts carried forward,		$57,648 23	$159,545 26

TABLE D — *Concluded.*

1896.					
		Amounts brought forward,		$57,648 23	$159,545 26
June	30,	By pay rolls for month, general,	$1,426 61		
	30,	By supplies for month, general,	106 20		
	30,	By pay rolls for month, Deer Island station,	640 15		
	30,	By supplies for month, Deer Island station,	89 81		
	30,	By pay rolls for month, East Boston station,	491 50		
	30,	By supplies for month, East Boston station,	9 38		
	30,	By pay rolls for month, Charlestown station,	401 16		
	30,	By supplies for month, Charlestown station,	27 82		
	30,	By pay rolls for month, Alewife Brook station,	189 24		
	30,	By supplies for month, Alewife Brook station,	30 52		
	30,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	500 00		
				3,912 39	
July	31,	By pay rolls for month, general,	$2,182 90		
	31,	By supplies for month, general,	637 66		
	31,	By pay rolls for month, Deer Island station,	502 20		
	31,	By supplies for month, Deer Island station,	312 25		
	31,	By pay rolls for month, East Boston station,	470 20		
	31,	By supplies for month, East Boston station,	602 20		
	31,	By pay rolls for month, Charlestown station,	384 68		
	31,	By supplies for month, Charlestown station,	315 72		
	31,	By pay rolls for month, Alewife Brook station,	195 06		
	31,	By supplies for month, Alewife Brook station,	261 35		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	1,016 66		
				6,880 88	

Aug.	31,	By pay rolls for month, general,	$1,361 01		
	31,	By supplies for month, general,	149 97		
	31,	By pay rolls for month, Deer Island station,	502 20		
	31,	By supplies for month, Deer Island station,	282 39		
	31,	By pay rolls for month, East Boston station,	452 24		
	31,	By supplies for month, East Boston station,	60 18		
	31,	By pay rolls for month, Charlestown station,	465 19		
	31,	By supplies for month, Charlestown station,	38 24		
	31,	By pay rolls for month, Alewife Brook station,	223 92		
	31,	By supplies for month, Alewife Brook station,	143 46		
	31,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	891 66		
				4,570 46	
Sept.	30,	By pay rolls for month, general,	$1,361 01		
	30,	By supplies for month, general,	1,578 20		
	30,	By pay rolls for month, Deer Island station,	507 15		
	30,	By supplies for month, Deer Island station,	2,370 68		
	30,	By pay rolls for month, East Boston station,	446 20		
	30,	By supplies for month, East Boston station,	1,996 08		
	30,	By pay rolls for month, Charlestown station,	440 25		
	30,	By supplies for month, Charlestown station,	969 04		
	30,	By pay rolls for month, Alewife Brook station,	249 93		
	30,	By supplies for month, Alewife Brook station,	138 51		
	30,	By proportionate expenses, commissioners, chief engineer, clerk and others for month,	891 68		
				10,948 73	
					83,960 69
		Balance,			$75,584 57

TABLE E. — *Maintaining and Operating Charles River Valley System.*

1895.	DR.			
Oct. 1,	To balance from appropriation for 1895,			$14,296 35
1896.				
Feb. 7,	To appropriation made by chapter 72, Acts of 1896,			30,000 00
				$44,296 35
1895.	CR.			
Oct. 31,	By amount paid city of Boston for disposing of sewage to Oct. 1, 1895,	$6,000 00		
31,	" " for salaries, commissioners, etc., to date,	716 67		
31,	" " for labor for month,	226 84		
31,	" " for supplies for month,	8 11		
			$6,951 62	
Nov. 30,	By amount paid for salaries, commissioners, etc., to date,	$50 00		
30,	" " for labor for month,	160 00		
30,	" " for supplies for month,	13 28		
			223 28	
Dec. 31,	By amount paid city of Boston for disposing of sewage to Jan. 1, 1896,	$6,000 00		
31,	" " for salaries, commissioners, etc., to date,	50 00		
31,	" " for labor for month,	302 70		
31,	" " for supplies for month,	4 98		
			6,357 68	
1896.				
Jan. 31,	By amount paid for salaries, commissioners, etc., to date,	$300 00		
31,	" " for labor for month,	186 45		
31,	" " for supplies for month,	4 48		
			490 93	

Feb.	29,	By amount paid for salaries for commissioners, etc., to date,	$300 00		
	29,	" " for labor for month,	211 00		
	29,	" " for supplies for month,	80 19		
				591 19	
March	31,	By amount paid for salaries, commissioners, etc., to date,	$300 00		
	31,	" " for labor for month,	188 00		
	31,	" " for supplies for month,	21 34		
				509 34	
April	11,	By amount paid city of Boston for disposing of sewage to April 1, 1896,	$6,750 00		
	30,	" " for salaries, commissioners, etc., to date,	50 00		
	30,	" " for labor for month,	132 50		
	30,	" " for supplies for month,	34 84		
				6,967 34	
May	31,	By amount paid for salaries, commissioners, etc., to date,	$50 00		
	31,	" " for labor for month,	306 64		
	31,	" " for supplies for month,	93 47		
				450 11	
June	30,	By amount paid for salaries, commissioners, etc., to date,	$50 00		
	30,	" " for labor for month,	212 00		
	30,	" " for supplies for month,	8 75		
				270 75	
July	8,	By amount paid city of Boston for disposing of sewage to July 1, 1896,	$6,750 00		
	31,	" " for salaries, commissioners, etc., to date,	370 00		
	31,	" " for labor for month,	213 00		
	31,	" " for supplies for month,	12 18		
				7,345 18	
		Amounts carried forward,		$30,157 42	$44,296 35

TABLE E — *Concluded.*

	Amounts brought forward,		$30,157 42	$44,296 35
1896.				
Aug. 31,	By amount paid for salaries, commissioners, etc., to date,	$300 00		
31,	" " for labor for month,	210 00		
31,	" " for supplies for month,	14 75		
			524 75	
Sept. 30,	By amount paid for salaries, commissioners, etc., to date,	$300 00		
30,	" " for labor for month,	220 00		
30,	" " for supplies for month,	27 17		
			547 17	
				31,229 34
	Balance,			$13,067 01

Expenditures of Board of Metropolitan Sewerage Commissioners to Sept. 30, 1896.

	Year ending Sept. 30, 1889.	Year ending Sept. 30, 1890.	Year ending Sept. 30, 1891.	Year ending Sept. 30, 1892.	Year ending Sept. 30, 1893.	Year ending Sept. 30, 1894.	Year ending Sept. 30, 1895.	Year ending Sept. 30, 1896.	Totals.
Office expenses, . . .	$1,161 29	$28,792 85	$30,437 29	$31,220 76	$35,191 97	$33,669 39	$19,652 19	–	–*
North Metropolitan system, .	–	116,492 55	582,966 06	962,798 49	1,172,269 02	1,115,190 19	606,488 61	$400,349 58	$4,956,554 50
Charles River system, . .	–	18,329 41	381,149 33	280,308 29	28,882 27	25,369 13	1,927 35	52,831 53	788,797 31
Both systems, . . .	–	2,696 20	5,597 86	7,703 15	12,783 61	15,864 20	302 20	–	–*
Neponset valley system, .	–	–	–	–	–	–	2,649 95	200,604 35	203,254 30
Wakefield branch, . .	–	–	–	–	–	–	–	125 98	125 98
	$1,161 29	$166,311 01	$1,000,150 54	$1,282,030 69	$1,249,126 87	$1,190,092 91	$631,020 30	$653,911 44	$5,948,732 09

Total expended to Sept. 30, 1896, ... $5,948,732 09

* The accounts "Office expenses" and "Both systems" are charged off to the North Metropolitan system and the Charles River valley system, — 85 per cent. to the former and 15 per cent. to the latter (North Metropolitan system, $191,312.02, Charles River valley system, $33,760.94). This is the proportion made by the apportionment commission in 1891 and has been found by experience to be substantially correct.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896.

North Metropolitan System.

	1895.			1896.			
	October.	November.	December.	January.	February.	March.	April.
Salaries, — engineers, inspectors and all others, including labor.	$2,179 48	$779 25	$2,174 56	–	$133 79	$1,441 95	$675 12
Travelling expenses,	14 00	115 09	11 71	–	6 17	3 04	21 33
Experts and appraisers,	66 70	–	–	–	–	–	–
Land takings, purchase and recording,	725 09	17,524 01	3 29	$8,996 19	394 63	–	2,462 37
Tools and repair of same,	9 80	1 95	1 05	–	–	–	–
Lumber and field supplies,	116 70	113 52	–	14 00	–	6 52	10
Advertising,	20 75	–	–	–	22 05	–	–
Legal services,	778 35	1,000 00	–	197 55	1,520 27	–	–
Postage, telegrams and express,	–	6 73	60	–	–	–	–
Carriage hire,	–	1 75	–	–	–	–	–
Photography,	–	–	3 26	–	–	–	–
Maps, plans and blue-prints,	–	–	–	–	35	–	2 50
*Section No. 1, Deer Island,	10 75	204 12	–	–	–	–	–
*Section No. 3½, Shirley Gut,	–	66 78	–	–	–	–	–
Section No. 7, East Boston and Winthrop — Trumbull & Ryan, contractors.	3,034 70	2,848 47	1,676 78	989 99	8 08	–	–
*Section No. 10, Chelsea Creek,	38 66	11 79	–	–	–	–	–
Section No. 11, Chelsea — Chas. Linehan, contractor.	–	–	1,235 03	–	–	–	–
Section No. 14, Chelsea — Metropolitan Construction Company, contractors.	–	–	–	2,313 65	–	–	–

*Section No. 25, Mystic River siphon, . .	20 00	–	–	–	–	–	–
Section No. 26, Charlestown and Somerville — H. P. Nawn, contractor.	–	–	–	–	–	–	30 50
Section No. 29, Cambridge — Lindsey & Cudmore, contractors.	15 00	–	–	–	–	–	–
Section No. 30, Cambridge — Jones & Meehan, contractors.	–	–	–	–	–	–	–
Section No. 31, Charlestown — Metropolitan Construction Company, contractors.	–	6 55	–	1,040 72	–	–	–
Section No. 32, Charlestown — Metropolitan Construction Company, contractors.	–	20	248 61	747 71	–	–	–
Section No. 35, Charlestown, Somerville and Medford — Jas. Heath & Son, contractors.	1,867 15	1,528 02	10 18	579 29	5,494 08	–	–
Section No. 38, East Boston — Jas. Heath & Son, contractors.	96 59	231 76	383 77	90 12	1,740 75	–	–
*Section No. 39, East Boston, ...	–	82 16	1 94	–	–	–	–
Section No. 43, Somerville and Cambridge — Metropolitan Construction Company, contractors.	–	4 10	–	–	–	–	–
*Section No. 48, Winchester, ...	725 13	36 60	4 13	–	1 67	–	6 25
Four-family dwelling-house at Deer Island — Hersee Bros., contractors.	1,340 26	3,713 56	1,487 50	1,549 28	2,816 73	–	–
*East Boston pumping station, ...	50 49	142 00	362 94	13 80	452 64	935 97	318 21
*Deer Island pumping station, ...	775 67	1,654 35	687 52	–	1,698 06	1,161 09	795 51
*Charlestown pumping station, ...	1,170 70	1,068 93	1,148 06	2,519 52	806 07	72 56	223 75
*Alewife Brook pumping station, . . .	1,131 55	2,304 12	893 68	1,282 15	443 93	362 00	36 90
Pumps for Deer Island pumping station — Edw. P. Allis Company, contractors.	–	–	–	–	–	–	15,050 00
Pumps for East Boston pumping station — Edw. P. Allis Company, contractors.	–	–	–	–	–	–	17,050 00

* Work done by day labor.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

North Metropolitan System — Continued.

	1895.			1896.			
	October.	November.	December.	January.	February.	March.	April.
Pumps for Charlestown pumping station — Edw. P. Allis Company, contractors.	–	–	–	–	–	–	$8,750 00
Charlestown pumping station — Edw. Lynch & Co., contractors.	$2,550 00	$4,028 14	–	–	$363 42	–	–
Alewife Brook pumping station — Wm. T. Eaton, contractor.	–	1,886 15	$743 47	–	114 38	–	–
East Boston coal-pocket — Wm. T. Eaton, contractor.	–	1,968 83	–	–	–	–	–
Deer Island coal-pocket and screen-house — Mack & Moore, contractors.	4,165 00	3,400 00	1,700 00	$3,155 15	–	–	354 36
Charlestown coal-pocket — Mack & Moore, contractors.	1,188 20	2,975 00	1,275 00	3,039 07	–	$38 07	242 06
East Boston screen-house — O'Connell & Furbish, contractors.	935 00	473 51	–	–	–	–	–
East Boston sea-wall — W. H. Wyman, contractor.	–	650 00	–	–	–	–	–
*Section No. 25½, Tufts' Mill Pond, . . .	100 80	–	–	–	–	–	–
*Alewife Brook coal-pocket, ...	–	–	–	–	–	–	–
Grand totals, ...	$23,126 52	$18,827 44	$14,053 08	$26,528 19	$16,017 07	$4,021 20	$46,018 96

* Work done by day labor.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

North Metropolitan System — Continued.

	1896.					Totals.
	May.	June.	July.	August.	September.	
Salaries, — engineers, inspectors and all others, including labor.	–	$296 80	$119 11	–	–	$7,800 06
Travelling expenses,	–	–	1 14	–	–	172 48
Experts and appraisers,	–	–	210 00	–	–	276 70
Land takings, purchase and recording,	–	–	–	–	–	30,105 58
Tools and repair of same,	–	–	–	–	–	12 80
Lumber and field supplies,	–	–	–	–	–	250 84
Advertising,	–	–	–	–	–	42 80
Legal services,	–	–	–	–	$838 75	4,334 92
Postage, telegrams and express,	–	–	–	–	–	7 33
Carriage hire,	–	–	–	–	–	1 75
Photography,	–	–	–	–	–	3 26
Maps, plans and blue-prints,	–	–	–	–	–	2 85
*Section No. 1, Deer Island,	–	–	–	–	–	214 87
*Section No. 3½, Shirley Gut,	–	–	–	–	–	66 78
Section No. 7, East Boston and Winthrop — Trumbull & Ryan, contractors.	–	–	5,001 50	–	–	13,559 52
*Section No. 10, Chelsea Creek,	–	–	–	–	–	50 45
Section No. 11, Chelsea — Chas. Linehan, contractor.	–	–	–	–	–	1,235 03
Section No. 14, Chelsea — Metropolitan Construction Company, contractors.	–	–	–	–	–	2,313 65
*Section No. 25, Mystic River siphon,	–	–	–	–	–	20 00

* Work done by day labor.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

North Metropolitan System — Concluded.

	1896.					Totals.
	May.	June.	July.	August.	September.	
Section No 26, Charlestown and Somerville — H. P. Nawn, contractor.	–	–	$11 75	–	–	$42 25
Section No. 29, Cambridge — Lindsey & Cudmore, contractors.	–	–	–	–	–	15 00
Section No. 30, Cambridge — Jones & Meehan, contractors.	–	–	417 20	–	–	417 20
Section No. 31, Charlestown — Metropolitan Construction Company, contractors.	–	–	–	–	–	1,047 27
Section No. 32, Charlestown — Metropolitan Construction Company, contractors.	–	–	295 50	–	–	1,292 02
Section No. 35, Charlestown, Somerville and Medford — Jas. Heath & Son, contractors.	–	–	–	$3,218 08	$110 00	12,806 80
Section No. 38, East Boston — Jas. Heath & Son, contractors.	–	$23 50	13 50	29 80	115 60	2,725 39
*Section No. 39, East Boston, ...	–	–	3,522 50	–	166 98	3,773 58
Section No. 43, Somerville and Cambridge — Metropolitan Construction Company, contractors.	–	–	–	–	–	4 10
*Section No. 48, Winchester, ...	–	–	–	–	–	773 78
Four-family dwelling-house at Deer Island — Hersee Bros., contractors.	$200 75	–	–	–	–	11,108 08
*East Boston pumping station, ...	–	13 59	116 55	1 67	15 00	2,422 86
*Deer Island pumping station, ...	–	1,210 52	1,008 84	64 16	98 99	9,154 71
*Charlestown pumping station, ...	445 85	591 04	675 96	42 86	26 85	8,792 15
*Alewife Brook pumping station, . . .	–	165 72	24 31	–	30	6,644 66

Pumps for Deer Island pumping station — Edw. P. Allis Company, contractors.	–	–	–	–	–	15,050 00
Pumps for East Boston pumping station — Edw. P. Allis Company, contractors.	–	–	–	–	–	17,050 00
Pumps for Charlestown pumping station — Edw. P. Allis Company, contractors.	–	10,250 00	–	–	–	19,000 00
Charlestown pumping station — Edw. Lynch & Co., contractors.	–	–	–	–	–	6,941 56
Alewife Brook pumping station — Wm. T. Eaton, contractor.	–	–	–	–	–	2,744 00
East Boston coal-pocket — Wm. T. Eaton, contractor.	–	–	–	–	–	1,968 83
Deer Island coal-pocket and screen-house — Mack & Moore, contractors.	–	–	–	–	–	12,774 51
Charlestown coal-pocket — Mack & Moore, contractors.	530 45	–	–	–	–	9,287 85
East Boston screen-house — O'Connell & Furbish, contractors.	–	–	–	–	–	1,408 51
East Boston sea-wall — W. H. Wyman, contractor.	–	–	–	–	–	650 00
*Section No. 25½ — Tufts' Mill Pond,	–	–	–	–	–	100 80
*Alewife Brook coal-pocket,	–	–	–	–	380 00	380 00
Grand totals,	$1,177 05	$12,551 17	$11,417 86	$3,356 57	$1,752 47	$208,847 58
Amount charged off from "Office Expenses" and "Both Systems" to Oct. 1, 1895,						191,312 02
85 per cent. of office expenses for year ending Sept. 30, 1896,						189 98
						$400,349 58

* Work done by day labor.

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

Neponset Valley System.

	1895.			1896.			
	October.	November.	December.	January.	February.	March.	April.
Salaries, — engineers, inspectors and all others, including labor,	$841 45	$258 68	$1,448 39	$0 75	$1,248 29	$1,462 40	$1,454 17
Commissioners,	250 00	250 00	250 00	250 00	250 00	250 00	250 00
Office supplies,	13 40	5 80	6 44	21 75	51 15	–	138 04
Travelling expenses,	66 00	33 25	55 80	35 00	126 69	–	110 31
Tools and repair of same,	1 55	6 50	3 85	–	3 05	–	21 50
Maps, plans, blue-prints, etc.,	48 95	12 56	4 05	–	11 00	–	2 98
Field supplies,	44 47	74 54	20 82	35 44	33 21	1 00	14 72
Telephone, telegrams and postage,	–	75	–	–	30	–	32 70
Teaming and express,	–	28 35	12 85	50	14 23	–	11 50
Carriage hire,	3 00	12 00	3 00	–	–	–	–
Clerk and chief engineer,	–	516 66	516 67	–	–	–	516 66
Clerical services,	–	125 00	125 00	–	–	–	–
Legal services,	–	125 00	125 00	–	–	–	–
Boat hire,	–	5 25	–	–	–	–	–
Engineers' instruments and repair of same,	–	–	–	–	–	–	44 25
Rent of offices,	–	–	–	–	254 17	254 17	254 17
Advertising,	–	–	–	–	–	–	94 97
Repairs, fittings and supplies at building No. 1 Mt. Vernon Street,	–	–	–	–	–	–	–
Care of offices,	–	–	–	–	–	–	–
Section No. 12,	–	–	–	–	–	–	226 90

Section No. 13,												75 17
Section No. 14,												—
Section No. 15,												—
Section No. 16,												—
Section No. 17,												—
Section No. 18,												—
Section No. 19,												—
Section No. 20,												—
Section No. 21,												—
Section No. 22,												—
Section No. 23,												—
Section No. 24,												—
Section No. 25,												—
Section No. 26,												—
Land takings, purchase and recording,												3 65
Totals,					$1,268 82	$1,454 34	$2,571 87	$343 44	$1,992 09	$1,967 57		$3,251 69

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

Neponset Valley System — Concluded.

	1896.					Totals.
	May.	June.	July.	August.	September.	
Salaries, — engineers, inspectors and all others, including labor,	$1,925 62	$5,813 26	$242 55	$3,569 57	$4,250 07	$22,515 20
Commissioners,	250 00	250 00	250 00	250 00	250 00	3,000 00
Office supplies,	594 40	207 56	57 98	206 67	214 86	1,518 05
Travelling expenses,	179 45	30 00	108 47	103 29	153 22	1,001 48
Tools and repair of same,	1 40	–	–	–	1 05	38 90
Maps, plans, blue-prints, etc ,	108 65	57 97	–	3 60	28 84	278 60
Field supplies,	130 65	168 90	224 60	122 76	95 87	966 98
Telephone, telegrams and postage,	45 30	18	1 30	80	49 37	130 70
Teaming and express,	26 75	–	–	43 20	25 17	162 55
Carriage hire,	15 00	–	12 00	–	34 00	79 00
Clerk and chief engineer,	516 66	516 68	–	–	–	2,583 33
Clerical services,	125 00	125 00	–	–	–	500 00
Legal services,	125 00	125 00	–	–	–	500 00
Boat hire,	–	–	–	–	2 00	7 25
Engineers' instruments and repair of same,	26 50	5 25	–	70	68 73	145 43
Rent of offices,	254 17	–	–	–	–	1,016 68
Advertising,	72 40	–	–	–	–	167 37
Repairs, fittings and supplies at building No. 1 Mt. Vernon Street,	952 74	574 30	25 46	12 68	26 14	1,591 32
Care of offices,	20 00	20 00	–	–	–	40 00
Section No. 12,	1,873 94	2,564 98	2,303 42	2,132 60	9,502 94	18,604 78

Section No. 13,	1,824 43	4,058 51	7,000 55	5,627 68	4,501 58	23,087 92
Section No. 14,	1,986 49	1,760 09	2,214 61	1,505 69	7,901 32	15,368 20
Section No. 15,	1,592 93	2,804 45	2,711 76	4,032 00	80 67	11,221 81
Section No. 16,	678 54	1,192 05	2,021 78	4,438 09	4,889 84	13,220 30
Section No. 17,	5 43	510 66	1,427 12	3,866 24	4,405 17	10,214 62
Section No. 18,	14 68	4,321 38	7,184 16	9,432 38	7,455 27	28,407 87
Section No. 19,	5 43	1,305 32	1,879 04	2,529 70	2,335 88	8,055 37
Section No. 20,	5 43	–	1,467 72	3,365 59	3,879 11	8,717 85
Section No. 21,	–	32 75	4 25	1,311 78	7,367 97	8,716 75
Section No. 22,	–	32 75	–	1,865 47	6,481 33	8,379 55
Section No. 23,	–	15 60	3 20	7 50	3,281 34	3,307 64
Section No. 24,	–	15 60	–	32 50	3,795 43	3,843 53
Section No. 25,	–	15 60	–	38 82	3,140 69	3,195 11
Section No. 26,	–	–	4 25	–	–	4 25
Land takings, purchase and recording,	–	4 00	–	–	8 31	15 96
Totals,	$13,356 99	$26,527 84	$29,144 22	$44,499 31	$74,226 17	$200,604 35

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

Charles River System.

	1895.		
	October.	November.	December.
Salaries, — engineers, inspector and all others, including labor, . .	–	–	$5 00
Land takings, purchase and recording, ...	$2,500 00	–	9,929 87
Legal services, ...	22 65	$1,200 00	2,816 75
Experts and appraisers, . . .	–	991 70	674 58
Grand totals, ...	$2,522 65	$2,191 70	$13,426 20

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

Charles River System — Concluded.

	1896.			Totals.
	February.	March.	April.	
Salaries, — engineers, inspector and all others, including labor,	–	–	–	$5 00
Land takings, purchase and recording, ...	–	–	$285 43	12,715 30
Legal services, ...	–	$11 10	–	4,050 50
Experts and appraisers, . .	$600 00	–	–	2,266 28
Grand totals, ...	$600 00	$11 10	$285 43	$19,037 08
Amount charged off from "Office Expenses" and "Both Systems" to Oct. 1, 1895, ...	. .	. .	. .	33,760 94
Fifteen per cent. of office expenses for year ending Sept. 30, 1896, ...	. .	. .	. .	33 51
				$52,831 53

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Continued.*

Wakefield Branch.

	September, 1896.
Travelling expenses,	$2 40
Tools and repair of same,	2 60
Field supplies,	0 20
Salaries, — engineers, inspectors and all others, including labor,	120 78
	$125 98

EXPENSES OF BOARD OF METROPOLITAN SEWERAGE COMMISSIONERS FOR THE YEAR ENDING SEPT. 30, 1896 — *Concluded.*

Office Expenses.

	1895.			1896.		Totals.
	October.	November.	December.	February.	April.	
Care of offices,	$20 00	–	–	–	–	$20 00
Travelling expenses,	4 91	$7 26	–	–	–	12 17
Blue-printing,	15	–	–	–	–	15
Office supplies,	37 37	64 32	$0 40	$0 33	$33 50	135 92
Maps, plans, blue-prints, etc.,	6 25	14 40	–	2 40	–	23 05
Postage, telegrams and express,	–	11 45	14 00	63	–	26 08
Land takings, purchase and recording,	–	–	2 50	–	–	2 50
Clerical services,	–	–	3 62	–	–	3 62
Totals,	$68 68	$97 43	$20 52	$3 36	$33 50	$223 49

Assets and Liabilities Sept. 30, 1896.

Assets.

Office furniture, fittings and supplies, including fittings for field offices, stationery and railroad tickets,		$2,890 84
Engineering instruments and supplies,		2,260 83
Engines, pumps, boilers, derricks, inclines, row-boats and heavy appliances,		3,198 00
Pumping station fixtures, tools and supplies,		9,633 74
Miscellaneous tools,		997 85
Miscellaneous supplies,		1,760 78
Engineers' field offices, sheds, barns, tool-houses,		2,262 00
Stock yard and building, East Boston,		2,500 00
House and lot, Pearl Street, Chelsea (due),		1,500 00
Vacant lots, Winthrop,		1,800 00
Cash received as follows: —		
Balance Sept. 30, 1895,	$2,257 64	
Rent of house 63 Pearl Street, Chelsea,	38 00	
Rent of room 34, Walker building,	100 00	
Rent of pumps,	40 25	
Sale of pipe, chains, etc.,	75 08	
Sale of land in Winchester,	5,500 00	
Sale of house and lot, Pearl Street, Chelsea (on account),	500 00	
Sale of kerosene and naphtha,	19 69	
Change of man-holes, Winchester,	23 50	
Bond of F. M. Wells,	100 00	
	$8,654 16	
March 16, 1896, paid treasurer and receiver-general (chapter 251, Acts of 1892),	5,500 00	
		3,154 16
		$31,958 20

There are numerous necessary plans, drawings, calculations and studies relating to the work to which no stated value can be assigned; also about fifty-four miles of completed sewer, with pumping stations, siphons and other accessories necessary for operating the systems.

LIABILITIES.

Amounts due contractors: —	
Reserved on estimates (sewers),	$39,673 15
Reserved on pumps,	12,900 00
Fractions of pay rolls (engineers),	1,352 89
Fractions of pay rolls (laborers),	235 93
Unpaid bills, miscellaneous,	1,325 82
	$55,487 79

There are also amounts due contractors upon a very few sections of the work, which will be paid on succeeding estimates or after the completion of the contracts.

METROPOLITAN SEWERAGE COMMISSIONERS.

MAP OF METROPOLITAN SEWERAGE DISTRICT.

SHOWING PROGRESS TO Sept. 30, 1896.

SCALE OF FEET.

NOTES.

Limit of Metropolitan Sewerage District ... indicated thus

Completed Metropolitan Sewers and Metropolitan Sewers under construction in Neponset Valley ... indicated thus

Projected Metropolitan Sewers in Neponset Valley and on Wellesley Branch ... indicated thus

Boston Main Drainage Sewers and Melrose Main Sewer to be acquired ... indicated thus

AREA OF METROPOLITAN SEWERAGE DISTRICT 159 SQ. MILES.

NORTH METROPOLITAN AREA 73 SQ. MILES.

CHARLES RIVER AREA 42 " "

NEPONSET VALLEY AREA 44 " "

TOTAL AREA INCLUDING WATER SURFACES 159 SQ. MILES.

WILMINGTON
READING
WAKEFIELD
LYNNFIELD
PEABODY
SALEM
MARBLEHEAD
SWAMPSCOTT
BILLERICA
WOBURN
SAUGUS
LYNN
BURLINGTON
STONEHAM
MELROSE
NAHANT
WINCHESTER
MEDFORD
MALDEN
REVERE
LEXINGTON
ARLINGTON
BELMONT
CAMBRIDGE
SOMERVILLE
EVERETT
CHELSEA
WINTHROP
WALTHAM
WATERTOWN
NEWTON
BROOKLINE
BOSTON
SOUTH BOSTON
DEER ISLAND
MOON ISLAND
WESTON
WELLESLEY
NEEDHAM
HYDE PARK
MILTON
QUINCY
WEYMOUTH
NATICK
DOVER
NORWOOD
CANTON
RANDOLPH
MEDFIELD
WALPOLE

NORTH METROPOLITAN AREA

CHARLES RIVER AREA

NEPONSET VALLEY AREA

MYSTIC VALLEY SEWER

PUMPING STA.

PUMPING STA.

PUMPING STA.

PUMPING STA.

WILMINGTON

READING

WAKEFI

BILLERICA

WOBURN

BURLINGTON

STONEHAM

WINCHESTER

MEDFORD

LEXINGTON

ARLINGTON

NORTH

METROPOLITAN

MYSTIC VALLEY SEWER

PUMPING STA.

EL. 122.75

EL. 133.98

EL. 117.88

EL. 113.97

EL. 111.03

EL. 108.02

EL. 108.72

EL. 110.32

EL. 111.17

EL. 97.58

EL. 97.20

EL. 147.50

EL. 128.08

EL. 147.0

EL. 140.9

EL. 125.0

15"

18"x24"

22"x27"

24"x29"

33"x36"

35"x38"

26"x28"

40"x42"

51"x54"

53"x56"

56"x61"

64"x68"

12"

18"

20"x30"

45"x49"

LYNNFIELD
PEABODY
SALEM
MARBLEHEAD
WAKEFIELD
SWAMPSCOTT
LYNN
SAUGUS
MELROSE
MALDEN
REVERE
NAHANT
NAHANT BAY
LYNN HARBOR
EVERETT
CHELSEA
EL. 145.63
EL. 147.0
15"
12"
18"
24"
EL. 140.0
20"x30"
25"x38"
EL. 125.0
45"x49"
56"x61"
98"x106"
EL. 100.51

PUMPING STA.

EL. 97.58

EL. 99.68

EL. 101.35

EL. 97.20

EL. 93.03

EL. 91.70

EL. 88.36

EL. 96.51

EL. 96.19

EL. 93.04

EL. 96

EL. 107.41

EL. 103.47

EL. 106.13

EL. 105.53

EL. 93.52

EL. 100.33

EL. 97.16

EL. 121.45

EL. 116.43

EL. 104.76

EL. 98.44

EL. 95

15"

18"

22"x28"

23"x33"

27"x28"

37"x

39"x48"

41"x46"

42"x48"

44"x50"

47"x53"

48"x54"

50"x57"

54"x61"

54"x62"

58"x63"

66"

66"x

77"x

78"

LINCOLN

BELMONT

WALTHAM

WATERTOWN

WEST WATERTOWN

CAMBRIDGE

FRESH POND

NEWTON

WESTON

WELLESLEY

WELLESLEY HILLS

BROOKLINE

ROXBURY

CHARLES RIVER BASIN

AREA

PUMPING STA.
72"x80"
106"
100"x110"
25"x34"
109"
109"
PUMPING STA.
40"x45"
109"
WINTHROP
109"
22"x28"
39"x48"
15"
18"
36"x41"
19"x28"
25"x34"
12"
15"
15"
12"
77"x
37"x44"
29"x37"
62"x69"
48"x54"
66"
78"
109"
109"
72"x120"
72"x75"
76"
PUMPING STA.
EL.97.20
EL.93.03
EL.102.71
EL.113.20
EL.88.59
EL.104.20
EL.113.05
EL.103.29
EL.74.22
EL.93.37
EL.94.84
EL.92.40
EL.99.85
EL.98.05
EL.96.72
EL.93.04
EL.96.29
EL.97.16
EL.98.44
EL.95.74
CHELSEA
EAST BOSTON
DEER ISLAND
BOSTON HARBOR
SOUTH BOSTON
OLD HARBOR
ROXBURY
MOON ISLAND
SQUANTUM
N.Y.N.H. & H.R.R.

NEEDHAM

WELLESLEY

WEST NEEDHAM

NEPONSET

HYDE PARK

NATICK

DOVER

MEDFIELD

WALPOLE

NORWOOD

CANT

EL. 177.10

EL. 174.09

EL. 165.0

EL. 148.96

EL. 144.84

EL. 137.74

EL. 131.78

45"x46"

48"x49"

48"x49"

51"x52"

30"3

NOTES.

Limit of Metropolitan Sewerage District ... indicated thus

Completed Metropolitan Sewers, and Metropolitan Sewers under construction in Neponset Valley ... indicated thus

Projected Metropolitan Sewers in Neponset Valley and on Wakefield Branch ... indicated thus

Boston Main Drainage Sewers, and Melrose Main Sewer to be acquired ... indicated thus

AREA O

NORTH M

CHARLES

NEPONSE

TOTAL A

GEO. H. WALKER & CO. LITH., BOSTON.

METROPOLITAN SEWERAGE COMMISSIONERS.

MAP OF METROPOLITAN SEWERAGE DISTRICT.

SHOWING PROGRESS TO Sept. 30, 1896.

NOTES.

AREA OF METROPOLITAN SEWERAGE DISTRICT	159. SQ. MILES.
NORTH METROPOLITAN AREA	73 SQ. MILES.
CHARLES RIVER AREA	42 " "
NEPONSET VALLEY AREA	44 " "
TOTAL AREA INCLUDING WATER SURFACES	159 SQ. MILES.

SCALE OF FEET.